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EARTHQUAKES IN OREGON

By WARREN DUPRÉ SMITH,
University of Oregon

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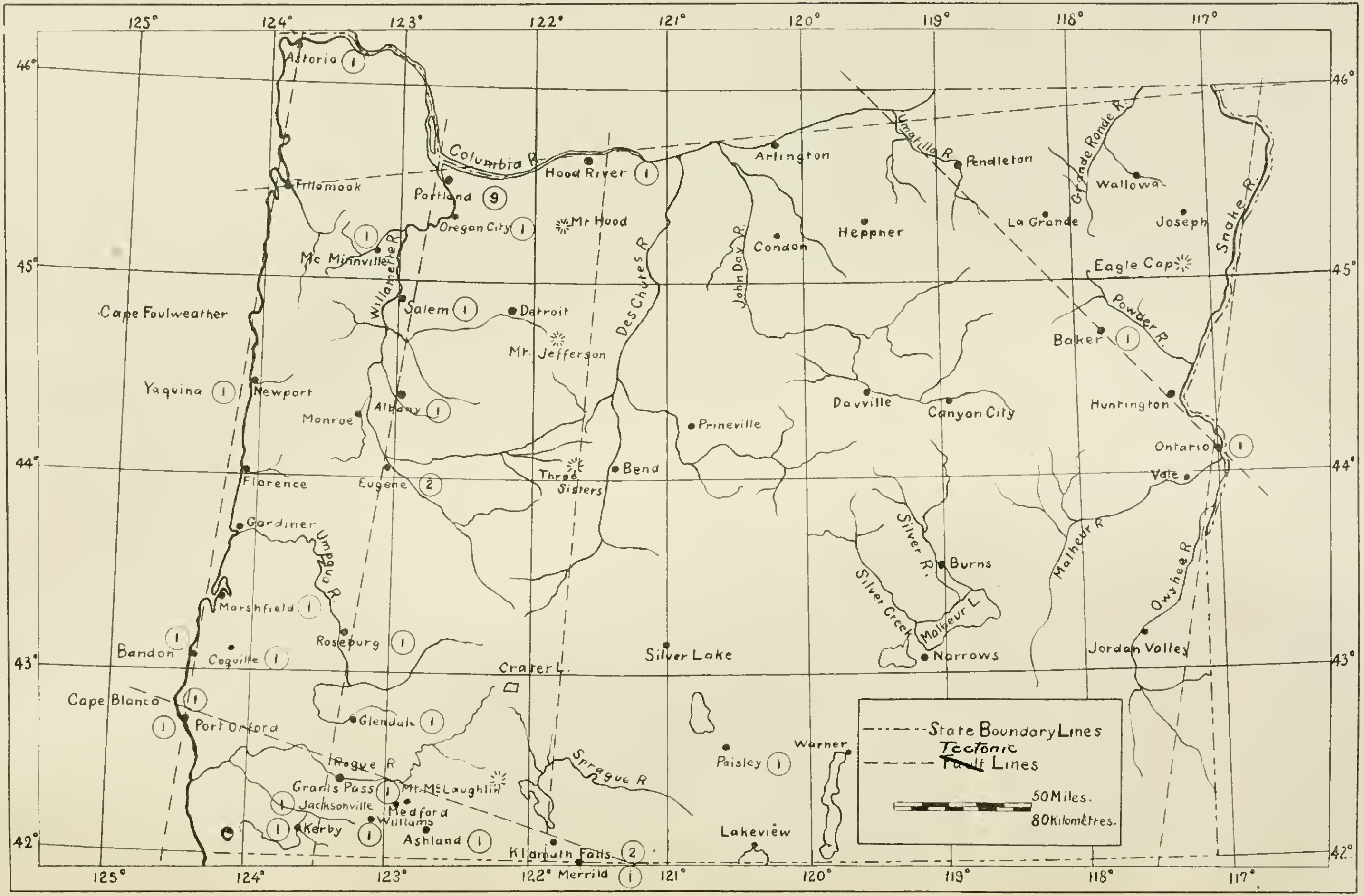

Fig. 1. Principal rift lines and earthquake localities in Oregon

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EARTHQUAKES IN OREGON

By Warren DuPré Smith

To one who has not investigated this subject it might appear that we were duplicating the famous story of snakes in Ireland. Such was the writer's opinion until, at the request of Dr. John C. Branner, he began to investigate the matter. To show that he was not alone in this opinion he will quote two persons who, it seems, should have been better informed.

On page 412 of his great work Count Montessus de Ballore,[1] perhaps the world's greatest authority on seismic phenomena, wrote in 1905 the following:

"Up to the present earthquakes upon the Pacific slope of Oregon have not been mentioned. There is, therefore, a seismic hiatus between Crescent City and Portland, Washington (he means Oregon). It coincides with the Cascade Range. However, on the 14th of December, 1873, a great temblor occurred along the epicentral line from Walla Walla to Portland, following the course of the Columbia and perpendicular to the coast. Deckert correlates this with the tectonic rift used by the river in cutting through the Cascade Range, and no other seismic line is known with this orientation. It is through this part of the range that the Cretaceous Sea of the Coast Range of California bent around the mouth of the Continental mass and extended into Eastern Oregon an unknown distance. This difference of geologic history from that of California is certainly not divorced from the difference in seismicity in the two regions and particularly as the stability of Oregon continues to the east of the Cascades in the country of the volcanic flows. The massif of the Klamaths was separated at the end of the Jurassic; a peneplain persisting across massifs of great resistance explains its immunity, through the antiquity of these breaks and through the absence of recent folding."

In the *Portland Oregonian*[6] of March 23, 1914, Weather Forecaster Theo. F. Drake, on being questioned with reference to the significance of suspicious sounds and jars felt in Portland on Sunday, March 22d, replied: "This locality is not subject to earthquakes, and we do not know positively that there has been one in this region." No less than seven undoubted earthquake shocks have been reported from Portland since 1852.

It is true that practically all of the shocks recorded in Oregon have been harmless, and, therefore, real estate will not run any serious risk of depreciation as a result of our study of them. But even were matters otherwise we should not be deterred in the least in the investigation. To outsiders the contention of San Francisco boosters that the great calamity of 1906 was not due to an earthquake but to fire seems rather puerile. Nothing is gained in this world by denying perfectly patent facts.

Another reason for undertaking this little study is the light it will throw on the geologic structure of Oregon and on the seismic investigations in the neighboring states of California and Washington. Geologic formations and phenomena (this for the benefit of the lay reader) are not confined by political boundaries.

This investigation has been handicapped by the lack of any persons or institutions whose particular business it might have been to keep accurate records of such earthquakes as have occurred. There is not in the entire state of Oregon a seismograph, and it appears that there never has been. The state of Washington has two and perhaps more, and California at least five such instruments in different institutions.

The list of earthquakes in this paper has been taken largely from that compiled by Holden[3], and has been supplemented by a few items from the one compiled by McAdie[5], and further added to by clippings from the press of Oregon. Especial acknowledgments are here made to Mr. Edgar B. Piper, managing editor of *The Oregonian,* who kindly supplied information of earthquakes which had occurred since the other two lists were published. I am convinced that many other temblors have escaped notice and record.

CAUSES OF EARTHQUAKES

As some of the readers of this article may not be as familiar with these phenomena as members of the Seismological Society, a few words will be inserted here as to the natural causes of earthquakes. These are three:

1. Rockfall.
2. Volcanism.
3. Tectonic displacements in the crust of the earth along fractures and faults.

The first has reference to all minor rock displacements such as caves in mines, along shores of oceans and lakes. The seismic effects from these are, of course, local, and their magnitude depends upon the amount of material falling.

In regions of active volcanism seismic disturbances are frequent. Many instances of this might be cited from various parts of the globe, but one will be sufficient. At the time of the great eruption of Taal Volcano in the Philippines in January, 1911, no less than 498 distinct shocks were recorded on the seismograph at Manila in the twenty-four hours during which the greatest explosion occurred. Some of these were hardly perceptible to the inhabitants of the city, while others were so noticeable as to be alarming. However, the two areas of greatest seismicity in those islands have no volcanos.

A third type of earthquake from the standpoint of origin is the tectonic, and this is the most common and most important. These are due to major differential movements of portions of the earth's crust along the larger and more persistent joint and rift lines, producing faults.

Such earthquakes as have occurred in recent times in Oregon, i. e., those which have been ordinarily noticeable, have probably all been of this type.

The lack of seismographs and accurate records of any kind requires the writer to put forward these statements only tentatively.

THE GEOLOGIC STRUCTURE AND FORMATIONS OF OREGON

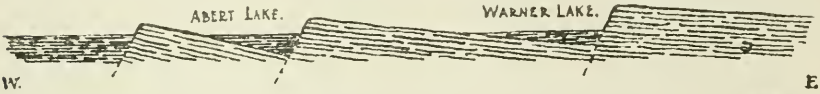
The general geology and geologic history of Oregon has been summarized by E. L. Packard and the writer[8] in the *Journal of Geology* for February-March, 1919. The reader is referred to that paper for this information.

All that is necessary at this time is to say that in Oregon there are rocks probably representing all eras. Only one doubtful outcrop of Archean is known, namely on Bald Mountain in the Blue Mountains of eastern Oregon.

The Paleozoic is better developed but undifferentiated. There are extensive outcrops of these rocks found in southwestern and northeastern portions of the state, forming Dr. Condon's well-known "Two Islands." There is also a considerable amount of Mesozoic rocks in isolated patches in these same regions.

By far the greatest proportion of the rocks are Tertiary. In western Oregon the Tertiary consists largely of marine sediments, in eastern Oregon it is basaltic lava or pyroclastics.

In the matter of structure we see also a distinct difference between western and eastern Oregon. In the west the rocks are folded with minor faults—east of the Cascades they are faulted with minor foldings. Examples of each of these types of structure can be seen in the case of folding near Roseburg along the Umpqua and in the Coos Bay coal fields and, for that matter, at hundreds of points in western Oregon. The fault block type of structure is exemplified in the escarpments of the Stein Mountains and around Abert, Warner, and other lakes, all studied and described years ago by Russell.[7] (See Fig 2.)



SKETCH SECTION THROUGH THE NORTHERN PART OF WARNER LAKE VALLEY, OREGON (AFTER RUSSELL)

Fig. 2.

The writer has made out a tentative list of the main tectonic lines in the state. About one or two of these there is more or less in question.

1. Columbia River Valley.
2. Willamette Valley.
3. Klamath-Hood Line.
4. Abert Lake Fault.
5. Surprise Valley or Warner Mountain Line.
6. Stein Mountain Fault.
7. Elkhorn Fault, near Baker.
8. Wallowa Mountain Fault.
9. Snake River.
10. Grande Ronde.

1. The Columbia River Valley. Whether or not this is a rift valley is not at all certain. There seems to be opinion in favor of erosion as the sole agent in the formation of this gorge while there is also the

belief on the part of others that there must have existed some sort of rift along a part of this line which the river has taken advantage of. The writer inclines to the latter view. The rocks on both banks of this stream are in the main basaltic lava and ash.

2. The Willamette Valley is also debatable ground since we do not certainly know whether this valley is an erosion valley, a structural (synclinal) rift valley or a combination of all three. In the writer's opinion it is a synclinal trough partly filled on the eastern side with basaltic lava and which has been filled up with detritus from the Coast and Cascade ranges and laterally planed by the Willamette River. That there are minor faults along its margins is certain, and some geologists have suggested a large one along the east side. Of this we have no direct evidence, and the stratigraphic basis upon which this supposition was first built has since been changed, and it is not now necessary to resort to this explanation.

3. Klamath-Hood Line. Beginning with the east fork of Hood River, which follows a rather straight north and south line, and continuing on south to a branch of the Deschutes, which also follows a north and south course and turns east just opposite Mount Jefferson, we pass through Lava and Davis lakes and finally skirt the west side of Klamath Lake. This line is so marked on the new relief map of the state made by Professor Solon Shedd for the State Bureau of Mines and Geology that we are led to believe that it marks a major fracture line in Oregon. Along this line the eastern Oregon lava fields have separated from the Cascade Plateau and dropped down about as the Great Basin block was dropped down from the Sierra Nevadas, though the throw is not so great.

4. The Abert Lake fault scarp is a conspicuous feature of the landscape, about twenty-five miles long and 2,000 feet high in some places. The down-throw side of this fault is partially covered by the lake of the same name. The rocks throughout this faulted region are in the main basaltic, but rhyolite and ash are found.

5. The Surprise Valley line, which begins in the valley of that name in California and continues north into Oregon, follows the west side of Warner Mountains, where a displacement of at least 2,000 feet is evident. Further south on this line, Russell says, at Eagle Peak this amounts to as much as 4,000 feet. This and the Abert fault extend for more than two degrees of latitude or at least 120 miles. These major fault lines are paralleled in almost any case by shorter lines of greater or less displacement (Fig. 1).

6. The Stein Mountains line is another very prominent fault line. According to Russell the "total observed length is about 100 miles, with a displacement where the mountains are highest of not less than 5,000 or 6,000 feet." Recent movement was noted in the vicinity of more than one of these lines by Russell, and to one of these Montessus de Ballore calls attention in his book on page 406:

"Some earthquakes have been mentioned at Fort Klamath, and it is not far from there in Surprise Valley and for great distances that Russell has noted the indications of recent movements along ancient fractures where the vegetation has not yet had time to obliterate the break; the subsidence amounts to as much as fifteen meters. It is difficult to doubt the relationship between the phenomena."

7. Lindgren in his report on the Blue Mountains[4] called attention years ago to a fault scarp along the front of the Elkhorn Mountains near Baker. This is a very prominent feature of the landscape, the triangular truncations of the mountain wall being typically developed there. This line trends northwest and southeast. The throw here amounts to at least 1,500 feet.

8. A similar escarpment runs along the north side of the Wallowa range, and there the displacement, according to the writer's observations, amounts to 2,500 to 3,000 feet. Neither one of these has been traced through its entire length. The trend of this line is northwest and southeast and roughly parallel to the Elkhorn line.

9. The Snake River gorge is another huge rift like that of the Columbia save that it is deeper and not so wide. Russell was of the opinion that the great gorge of this stream, 4,000 feet deep at Asotin, was due to erosion. It seems to the writer that there must have been a rift of some kind which the stream has taken advantage of.

10. The peculiar course of the Grande Ronde system of drainage makes us resort to faulting to explain its anomalous directions. Wallowa River, its largest tributary, flows northwest for about fifty miles, then at the junction with the Grande Ronde turns southwest. Of course, this might be explained by slow differential uplift of the land in such a way as to force the stream to make its present considerable detour.

We have now traced out some of the more prominent lines along which displacements have probably taken place in the past and may be continuing to do so now. There are others doubtless of which we are ignorant, some perhaps as large as these and many smaller ones certainly. On the map (Fig. 1) we have placed all these lines which we have called attention to with the location of the earthquakes given in the lists.

CATALOG OF EARTHQUAKES IN OREGON

1846-52. Exact date not given; Oregon City.

In Oregon City, on Rock Creek, near Portland, explosions like those of a cannon were heard for nearly the whole of a day. At first these were about half an hour apart; then they came nearer together, until at last they were no further apart than one minute or so; finally they died away. The water in Rock Creek did not run for three days.—Verbal account of George J. Ainsworth.

1865. November 26 (?); at sea.

Between San Francisco and Portland, an earthquake.—*Mining and Scientific Press.*

1867. January 8; daylight (?); X; Fort Klamath.

Frightful earthquake at Fort Klamath, Oregon; the Klamath Lake fell six feet.—Fuchs. Two shocks, the second frightful. The air grew dark, ashes fell as thickly as snow in a storm.—B. Ms.—P. gives VIII (??).

The following letter is to the *Oregon Sentinel,* from Fort Klamath, dated January 8, 1867:

Editor Sentinel:—We have singular, if not serious news, to send by the express just leaving. This morning at daylight we were startled from our sleep by the precipitate shock of an earthquake, immediately followed by a noise as of distant thunder. But in a little while quiet reigned, and every one was conversing and laughing heartily at the singular phenomenon; but our countenances soon underwent a serious change, for it began to grow dark; the whole heavens were full of a very black smoke or cloud; the air had a sulphurous smell; and ashes of a brownish color fell as fast as I ever saw it snow. We had to use candles in the mess-room. Most of us went in to breakfast, but had only got fairly into our seats, when horror upon horror, the earth seemed rolling like waves upon the ocean; everyone was thrown to the floor, only, on regaining their feet, to be placed in the same position again, accompanied with the rattling of dishes, the crashing of window glass, cracking of timber of buildings, and the screams of the frightened. You could not imagine a more perfect chaos. Some of us had gained the door, and such a sight met our gaze as was probably never before beheld. The tall pines around the fort seemed lashing themselves into fury; the wagons in front of the stable were engaged in a pitched battle; horses and cattle were lying crouched upon the ground, uttering the most pitiful moans; dogs were howling, and the unearthly cries of the Klamath Indians camped near the fort, completed the scene. The sutler's store was thrown about ninety feet from its former position. There is no very serious damage done to any of the buildings, all being log and frame houses, but I do not think there is a whole pane of glass left at the post. Most of us are of the opinion that a volcano has broken loose near the Klamath marsh, as a continuous dark column of smoke is seen in that direction. There was but half an hour between the first and second shocks. The first was just perceptible. The second lasted, as near as can be judged from various opinions, from two to three minutes. Further particulars will be given by the next express. L. TENNYSON, Quartermaster's Clerk.

Mr. Whitmore has just arrived from the agency, and reports that the lake (Klamath) has lowered about six feet, and is still falling. Crooked Creek, a stream between this place and the agency, is completely dried up.—B. Ms., *San Francisco Bulletin,* January 14, 1867.

1872. December 16; Eugene.

One shock.

1873. November 22; a little after 9 p.m.; VIII.

A shock was felt from Portland, Oregon, to San Francisco, California, more severe at Crescent City, Cal., and Port Orford, Oregon.—C. G. R. Nearly every brick building in Crescent City was injured; chimneys were damaged there and up the coast to Port Orford, in the interior as far as Jacksonville, Oregon, and east from Crescent as far as Happy Camp, on the Klamath.—B. Ms. At sea, N. of Cape Mendocino—C. G. R.—Tacoma (III).—P.

Severe shock at Linckville, Klamath Lake, Oregon. In Jackson and Josephine counties, Oregon, and Trinity county, Cal., the shock was strong and lasted nearly a minute.—B. Ms.—Ft. Klamath, Oregon.—B. Ms. Red Bluff; Eureka; Albany (Oregon); Roseburg—C. G. R.

1883. September 28; about midnight; Portland.

Two shocks, Portland.—C. G. R.—0h. 0m. 10s., Portland. Two shocks.—P.

1891. November 8; 8 p.m.; Ashland.

Following is the newspaper account; "The first time an earthquake has been felt in Ashland for years was last night about 8 o'clock when a distinct shock, though light and lasting only a very few seconds, caused a general rattling of window panes in many buildings in town. The shock was not heavy enough to cause even timid people any alarm."

1892. February 3; 8:30 p.m.; Portland.

A severe earthquake shock occurred here at 8:30 o'clock tonight. Brick buildings swayed and windows rattled, terrifying the inmates, who in many instances rushed into the street. The shock lasted about thirty seconds, and was probably the most severe earthquake ever felt in this city. As far as known no damage was done (VII).

1892. February 3; 8:27 p.m.; Astoria.

The vibrations were from southwest to northeast. It lasted about three seconds, causing houses to shake perceptibly, but no damage was done.

1892. February 3; 8:32 p.m.; Salem.

The vibrations were from northeast to southwest. There were three distinct shocks. Windows rattled and buildings trembled, but no damage is reported.

1892. February 3; 8:20 p.m.; Yaquina Head Lighthouse.

A light shock about 8:20 p.m. Warrior Rock Lighthouse (Columbia River) a shock February 3, at 8:40 p.m.; N. to S.

1892. April 17; 2:50 p.m.; Portland.

At 2:50 o'clock this afternoon two heavy shocks. They lasted about ten seconds each and the vibrations were from west to east. Many persons became frightened and rushed into the street when the buildings began to tremble. No damage. The observer of U. S. Weather Bureau reports *one* light shock at 2:56 p.m.

1895. February 25; 4:47 a.m., Standard time; Portland.

Three slight shocks from northward. Intensity III.

Tacoma, Washington, and points to the southward; same time. Three slight shocks from S. 10° W., intensity III. Green River Mines, Intensity V. My "home-made" seismograph only records horizontal shocks and showed only $^1/_{20}$ inch. The directions noted would place center near Toutle River, where I observed a vertical shock—already reported (1893)—F. G. Plummer, Tacoma, Washington.

Portland, Ore. Three distinct shocks of earthquake were felt here early this morning. Each shock lasted about three seconds. The first occurred at 4:47. The vibrations were from north to south.—*San Jose Mercury*, February 26, 1895.

1896. April 2; 3:20 a.m.; Portland.

About 3:20 a.m. a single shock of brief duration was felt here. The shock was felt as far south as Salem.

McMinnville, Ore. The inhabitants were awakened at 3:17 this morning by an earthquake (VI). Two or three distinct shocks followed in quick succession, with a loud rumbling noise coming from the west. The earth appeared to tip toward the east.—*San Francisco Chronicle*.

1896. June 5; 10:20 p.m.; Cape Blanco Lighthouse.

Tower vibrated considerably for about 30 seconds. I could not say positively that it was caused by an earthquake.—Mss. kindly communicated by the U. S. L. H. Board.

1896. August 26; Mount Hood.

Newspaper dispatches report the narrow escape of a party of tourists on Mount Hood on the afternoon of August 26th from an avalanche. The dispatches convey the impression of a volcanic eruption, but it seems entirely possible to explain the occurrence without any such assumption. A slight earthquake may have accompanied, or even caused, the avalanche. No reports have been received of any disturbances elsewhere on that day.

1902. December 2; 2 a.m.; Kerby.

S. T. Meissner reported slight shock.

1902. December 4; between 8 and 9 p.m.; Hood River.

Reported by J. Hengst. (These two items from McAdie's list.[5])

1906. April 18; Paisley, Coquille, Eugene, Bandon, Williams, Glendale, Marshfield, Merrill; no details.

Waring says:—"Judging from all I could learn, I think over most of south central Oregon the vibration was hardly perceptible to people awake. At Paisley and at Merrill stronger shocks were felt. The shock at Paisley was peculiar in being early Thursday morning, April 19, a sort of 'sympathetic' shock. No information concerning the time of the shock at Merrill was obtained, but I think it was on Wednesday morning at the time of the great quake. The greater intensity of shock at these two places is perhaps due to the underlying formation. Paisley is built on river ground at the edge of the Chewancan Marsh. Merrill lies in or near Langell's Valley, by Lost River, which here sinks and flows through swampy land in several places." From "Report of California Earthquake Commission," Vol. 1, Pt. 1, p. 163.

1913. March 15; Medford.

A slight earthquake occurred at 12:40 p. m. No damage was done (*Bull. Seism. Soc. Am.*, 3, 35).

1913. October 14; Eastern Oregon.

A rather severe earthquake is reported to have occurred at 3:00 p. m., in the Seven Devils district, along the Idaho-Oregon line. Reports state that the shock lasted one minute, shook houses and broke windows and dishes (*Bull. Seism. Soc. Am.*, 3, 204).

1914. March 22; 6:30 a.m.; Portland.

Inquiries were received at the *Oregonian* office on March 23rd relating to jars felt at 6:30 a.m. the day before (Sunday). Inquiries came from residents of Portland Heights. Weather forecaster Theo. F. Drake is reported to have said, "This locality is not subject to earthquakes and we do not know positively that there has ever been one in this region." (Seven previous ones are recorded. W. D. S.) The jar lasted from five to ten seconds. Shock felt by hundreds. Rattled furniture. No report of a blast or noise given.

1914. September 6; 2 a.m.; Portland.

Faint vibrations caused by the earthquake reported from the north early yesterday were felt by various Portland residents. Time 2 a.m. "Objects appeared to be rocking." Reported also from Castle Rock, Washington.

1915. May 19; 7 p.m.; Portland.

"A shock, defined by many east-side residents as a distinct earthquake, was felt throughout east side last night at 7 o'clock. The tremor lasted from one to two seconds, vibrated from east to west and rattled dishes, rocked chairs, disarranged books in bookcases, and generally caused fright and commotion. The vibrations were felt over an area of several miles in radius extending from remote parts of Rose City Park district to the southern extremity of Mount Tabor. Some reported feeling three distinct shocks.

1915. October 2; Baker and Ontario.

Shocks lasted several seconds at Ontario. This shock was felt at Stockton, Fresno, and Sacramento, California; Reno, Nevada, and at Salt Lake City, Utah.

1916. January 5; Newport.

A sharp earthquake was felt but no damage was done (*Bull. Seism. Soc. Am.*, 6, 49).

INTERPRETATION OF THE RECORDED EARTHQUAKES

Inspection of the map giving the location of recorded earthquakes in Oregon seems to indicate the following:

First, that most of the recorded earthquakes have occurred in or near the Willamette Valley. However, this may merely mean that we have better records of earthquakes from towns in the valley than from the smaller places outside the valley.

Second, there seems very clearly to be a line of weakness along or paralleling the Oregon Coast. This is what we would expect. Whether there is a fracture line, following the edge of the continental shelf or the actual coast line, we are unable to say.

Third, the predominance of recorded shocks in or near Portland may mean much or little. It is quite probable that, as many suppose, there is a major rift line along the course of the Columbia River and another one along the axis of the Willamette, and Portland is situated at the intersection of the two. It has been shown by the work of the Italian geologists that in Calabria all such intersections have been found to be especially seismic locations. On the other hand, it may be that with more people to notice them several mild earthquakes have been recorded in the city which in more sparsely settled regions would have passed unnoticed. Portland is built on a bench or benches of sand and gravel which have been given the name of the Satsop Formation. Of course such material would exaggerate the normal effects of earth tremors.

Fourth, from the description, it would seem that the so-called earthquake at Klamath Falls on January 8, 1867, was a volcanic eruption, accompanied by earthquakes. If there was an eruption, where was it? Lassen or one of the many dormant peaks nearer than Lassen? It is possible that there exist more definite statements about this event in the records of the War Department at Washington. However, we might get nearly all of these phenomena exhibited at the time of a very severe tectonic earthquake, allowing something, of course, for exaggeration in the report, due to fright or an over-sensitive imagination. If this disturbance was due to tectonic movements they might well be referred to the line which we have already indicatd as running along the eastern side of the Cascades from Klamath Lake to Hood River. However, we have no records from further north along the line, perhaps for the very good reason that there were no white people at that time there to record anything.

Fifth, on October 2, 1915, an earthquake was felt at both Baker and Ontario, on the Snake River. This points to a line running through these two places which, if projected, would pass pretty close to Pendleton and Umatilla. From these two last-named places we have no records. This line is indicated at Baker by the prominent fault scarps of the Elkhorn Range.*

The effects of the great San Francisco earthquake of 1906, according to investigations made by Waring and given on page 163 of volume I, part 1, of "The California Earthquake Commission Report,"[2] were felt less in eastern Oregon than along the coast of Oregon. This again is just what we would expect, since the California earthquake was due to the San Andreas rift which lies near the coast and which seems to have its continuation on land near Cape Mendocino, California. As far as we now know, this fault has not been found farther north, in Oregon, though traces of it might well exist. It is not impossible that this line does continue north into Oregon by way of Jacksonville, Roseburg, and the Willamette Valley, as the recorded shocks seem to indicate. These, we believe, are about all the generalizations we can risk making at this time. Our data are altogether too meager to warrant more now.

NEED OF INSTRUMENTS AND MORE ACCURATE RECORDS IN OREGON

Since there is nowhere in Oregon a seismograph of any description there should be one. It is planned to install some equipment along this line at the University of Oregon in the near future. A Bosch-Omori instrument would probably be the best type of general seismograph, but unfortunately, owing to war conditions, we cannot get these, perhaps for some time.

To some it may seem that the study of earthquakes is a fruitless and impractical undertaking. Our answer to this is that the study of earthquakes throws considerable light on the problems of the structure of the earth, and we are not ready to say, because there seems to be no immediately forthcoming practical result of such study, therefore it should be abandoned. Oregon must sooner or later get out of the unenviable position of being a debtor to the rest of the world in matters of scientific research.

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*The epicentral region of this shock was in Pleasant Valley, Nevada, where there was vertical surface movement for a distance of twenty miles. This earthquake was investigated by Professor J. C. Jones and the results published in the *Bulletin of the Seismological Society of America*, **5**, 190.—Ed.

SUMMARY

Neither in number nor in intensity has Oregon suffered from earthquakes, and so far the subject is one of scientific interest only. The number of earthquakes on record to date is thirty, and these appear all to be of tectonic origin. There is not an actual, but only an apparent seismic hiatus between California and the state of Washington.

Oregon needs at least one complete seismograph, and an accurate study of this important and interesting subject should be begun at once.

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9. *Bulletin of Seismological Society of America*, **3** and **6** Stanford University, California.

University of Oregon

THE FOSTER-CHILD FANTASY

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This study was designed to test the validity of the generalization made by the psycho-analysts that most or all children experience the foster-child fantasy, and to determine some further facts concerning the phenomenon. As a stage in the development of the "family romance" it is said that all or nearly all children conceive the notion that they are the children of much greater parentage. If this is so, especially as some think that it exerts much influence upon the conduct of the child, it is of great interest to students of childhood and adolescence.

The generalization seems to be well on the way toward acceptation. Abraham apparently considers it universal and sufficiently well demonstrated (1. pages 40-41). Adler refers to it as a not infrequent occurrence (2. page 206). Hall in his interpretation of Jesus' concept of divine parentage treats the foster-child fantasy as a very common experience of childhood (3. pages 251-2). Jelliffe is more daring and states that the family romance is a "universal phenomenon" (4. page 54), although he adds that any stage, and this could of course apply to the foster-child stage, may be "much abbreviated." White treats it as established in his introduction to psycho-analytic psychology (6.). Many Freudian writers, however, refer to or use the concept of the family romance with an air of certainty but without specific mention of the foster-child fantasy. Possibly they assume its existence as a part of the romance. Rank's study of the myth of the birth of the hero is most frequently given as reference (5.). Both Jelliffe and White quote Rank's presentation at length. And Rank presents the matter with apparent confidence in the conclusiveness of its demonstration. He also says that psychoanalyses are the only means of determining such traits (5. page 63).

Acceptance of the establishment of the foster-child fantasy as a common trait of childhood has hitherto depended upon the validity of conclusions from psychoanalyses, of psychoneurotic adults mostly, some of whom died long prior to the time of the analysis. That Rank's presentation so often quoted occurs in the course of a study of mythology should not be permitted to lead to the supposition that it is an induction from his myth data. He himself says that it is a summary of the traits of childhood discovered by Freud ''from his experience with the psychology of the neuroses'' (5. page 63). Whatever may be thought of the validity of generalization from such data, it must be evident that here is an opportunity for checking the results of psycho-analytic work by use of another psychological tool, the questionnaire. In fact it is for just such work as this that the questionnaire is best suited, for a census of certain human experiences. If it is true that most children wonder whether ''they can really be the offspring of their prosaic parents'' and develop notions about their real parentage, then it should not have entirely disappeared from voluntary recall by mid- or even later adolescent years. Hence questions presented to adolescents under circumstances calculated to arouse a sober attitude of willingness to cooperate should produce other and valuable evidence concerning the frequency and nature of the foster-child fantasy and serve at the same time as a check upon the generalization made from psycho-analyses. Such is the nature of the study here presented.

With such a purpose, the questionnaire could be very simple and direct. After many preliminary experiments it was finally used in the following form:

It has been observed that some people during childhood or youth acquire the notion that their parents are merely foster parents. The purpose of this questionnaire is to determine how common such an experience is and some facts about it.

Your sincere effort to answer the following questions accurately will be appreciated.

Negative answers if true are just as valuable as positive.

Write answers in the space following each question.

1. Age at present.
2. Sex.
3. Did you ever have the experience of day dreaming or believing that you were an adopted or foster-child, that your supposed parents were not your real parents? (Answer yes or no).
4. Was it merely a day dream or did you believe it to be true?
5. Who or what did you think that you were?
6. If you can remember what caused such thoughts, please state it as clearly as you can.
7. About how old were you at the time?
8. Did these ideas lead you to any special acts or changes of conduct? If so, please state what.

9. If you believed yourself an adopted or foster-child, about how long did the belief last?

10. Has the belief disappeared? Tell why it disappeared if you can.

11. State below any remarks or information which may be of interest concerning the matter.

This was answered by students in scientific departments of the University of Oregon and by students in the two upper classes of eight different high schools in the same state. The college students wrote under the supervision of the writer or one of his colleagues in psychology. In the high schools they were written under the supervision of the superintendent or principal, people experienced in the handling of students and here selected for their interest in research. Several of them had formerly been students in the writer's department. In order to insure as nearly perfect uniformity in the presentation of the questionnaire as possible, printed directions were supplied to all who assisted in its presentation. Care was taken to make certain that the students understood that a serious purpose existed for the questions, which otherwise might have provoked frivolity, and by this means serious answers were obtained. Out of more than nine hundred returns only five bore any indication of insincerity. However otherwise this study may be attacked the author is confident that insincerity in its data is not one of its weaknesses.

Nine hundred and twenty one returns came to the writer. Of this number five were rejected because of apparent insincerity, ten because of failure to answer some important question such as age or sex, and two more were dropped because they were actual instances of foster children. Thus the total number of returns upon which this study is based became 904. Of these 640 were from the two upper classes in the high schools and the remaining 264 were college students, mostly freshmen and sophomores. Their distribution by age and sex follows:

Age	14	15	16	17	18	19	20	21	22	23	24	25	over 25	Total	Per cent
Male	2	11	38	86	68	56	44	21	13	5	5	2	7	358 or	39.6
Female	5	16	70	168	134	69	43	17	11	6	4	3	6	546 or	60.4
Total	7	21	108	254	202	125	87	38	24	11	9	5	13	904	

Socially this group might best be characterized as homogeneously American. Students of foreign born parents were few and students of foreign birth rare. They came as a rule from homes of moderate to considerable culture, identified chiefly with commercial, agricultural or professional pursuits. Extreme poverty or utter illiteracy would rarely be found.

FREQUENCY OF THE FANTASY

Question No. 3 was designed to discover the frequency of recallability of the fantasy and was worded to include with affirmative answers all degrees of belief or unbelief. It was answered by all of the 904 students participating in the study. The distribution of the answers was as follows, affirmative indicating recall of some experience with the fantasy and negative no immediate recall:

	Male	Female	Total
Affirmative	87 or 24.3%	171 or 31.4%	258 or 28.5%
Negative	271 or 75.7%	375 or 68.6%	646 or 71.5%
Total	358	546	904

AGE DISTRIBUTION OF ANSWERS TO QUESTION NO. 3

Age	14	15	16	17	18	19	20	21	22	23	24	25	over 25	Total
Affirmative														
Male	1	4	8	27	13	8	13	4	3	1	3		2	87
Female	1	2	22	50	41	20	14	8	2	5	2	2	2	171
Total affirmative	2	6	30	77	54	28	27	12	5	6	5	2	4	258
Negative														
Male	1	7	30	59	55	48	31	17	10	4	2	2	5	271
Female	4	8	48	118	93	49	29	9	9	1	2	1	4	375
Total negative	5	15	78	177	148	97	60	26	19	5	4	3	9	646
Grand total	7	21	108	254	202	125	87	38	24	11	9	5	13	904

It will be observed that the median for the affirmative group is the same as for the negative group. The likeness of these distributions indicates that there is no significant change in the frequency of recallability with age, that for the mid-adolescent years at least there is no rapid suppression. The older ones recall the experience as frequently as the younger. If this phenomenon continues on into the higher ages it would be out of harmony with the psychoanalysts' assertions concerning the disappearance of childhood fantasies from voluntary recall, but the data here for the upper ages is not sufficient for generalization. It merely suggests an alluring opportunity for further research. That 28 per cent, however, of this group of more than nine hundred young people can immediately recall having experienced the fantasy does lend considerable support to the assertions of the psychoanalysts concerning its frequency.

ATTITUDE TOWARD THE FANTASY

Preliminary experimentation and inquiry revealed that some people could recall definitely having experience with the fantasy but merely as a day dream while others had actually believed themselves foster-children. For this reason question No. 4 was designed to bring out the frequency of the two groups, but it did rather more than was expected. It led to answers which revealed many gradations of belief. Some would not even admit that it was a day dream and used expressions of which a few follow:—"I merely wondered if I might belong some place else," "Just a casual thought," "Did not believe it to be true but thought of possibilities if it was," "Merely wondered," "Merely a random thought not developed to any degree or thought of later," "Just pretending," "Just a thought that I knew at the time wasn't so," "I liked to pretend my parents were foster parents." For the lack of a better term such answers were classified below under the heading, Casual Thought. Of those who answered that they believed their fantasy to be true some added qualifying phrases which also indicate gradations on the scale of belief but at the other end of the scale from the samples just given. Here follow some of the phrases in the belief group:—"I believed that it might be true," "I perhaps believed it true," "Day dream at first later believed it to be so." "Half believed it at the time," "I believed it or rather hoped it to be true," "Perhaps I did not fully believe I had foster parents but I doubted that my parents were truly mine." But most of the answers in this group leave no room for doubt for they are such phrases as "I believed it" or "I thought it to be true." The day dream group also indicates occasionally such gradations of belief as indicated by the following quotations:—"A day dream but at times was uncertain," "Merely a day dream rather wishing I might be some one else's child," "......wondering how it would feel to be a foster child," "Day dream but I nearly believed it to be true," "It was dreaming I suppose and yet I often thought that perhaps I had had a different father," "Day dream afraid it might be." Below are the frequencies of the answers in tabular form.

FREQUENCY OF BELIEF IN THE FANTASY
(Answers to Question No. 4)

	Male	Female	Total
Belief	17 (19.5%)	54 (31.6%)	71 (25.4%
Day dream	58	101	159
Casual thought	12	15	27
No answer	—	1	1
Totals	87	171	258

From this it will be seen that all but one of those who answered question No. 3 affirmatively gave some indication of their attitude toward the fantasy. Twenty five per cent of all who could recall the experience recall it as being believed at the time. More than 19 per cent of the males believed it and more than 31 per cent of the females. Of all the 904 answering the questionnaire 7.8 per cent recall experiences of the fantasy and believed it, 4.5 per cent of all the males had it and believed it, and so did 10 per cent of all females.

FORMS OF THE FANTASY

(Answers to Question No. 5)

Answers to this question indicated several degrees of development of the fantasy. Many returns merely said "adopted child" or "Never thought that far" or other words with like meaning. Such answers are grouped in the table below under the first heading as they seem to represent an incipient or undeveloped stage of the fantasy. Then there are those, of considerable number, who thought themselves foundlings of insignificant inheritance or destitute orphans who had been taken out of pity from an asylum. A few of those answered with the single word, orphan; but most gave some qualifying phrase or word which indicated socially inferior origin. These are all grouped below under the second head. A small number very clearly stated that they thought themselves children of parentage of a similar social status (third heading in the table). Another considerable group had developed ideas of greatness. Kings, princes, great wealth, great beauty, great intellectual powers,—all these figured in the concepts of their supposed true parentage. A few thought of themselves as strange, mysterious or supernatural beings, using these very adjectives on their returns, and they are so described in the table. It may be worth while to add that these few did not all come from any one community but from different parts of the state, thereby eliminating the possibility of collusion. Then there were those who recalled the fluctuating nature of the fantasy and report themselves as thinking of now one and now another type of person. Under Miscellaneous and Indefinite are presented those who gave such answers as "Kidnapped," "Traded by mistake," etc. making them otherwise unclassifiable. The frequency of occurrence of each group is indicated below as well as the percentage which the total of that group is of the entire number answering this question.

	Male	Female	Total
Incipient stage of fantasy (No clear concept)	47	75	122 or 54%
Orphan or foundling	7	26	33 or 15%
Parentage of similar social status	2	5	7 or 3%
Child of great parentage (Great wealth 20, royalty or nobility 11, miscellaneous 9)	8	32	40 or 18%
Strange, mysterious or supernatural being	4	1	5 or 2%
Many different characters	4	6	10 or 4%
Miscellaneous and indefinite	2	5	7 or 3%
Totals	74	150	224

Of the two hundred and fifty eight people whose answers to Question No. 3 indicated experience of the fantasy, two hundred and twenty-four or 87 per cent answered this question. It was answered by 85 per cent of the males and 88 per cent of the females who answered No. 3 affirmatively.

Causes Offered for the Fantasy

The following table summarizes the answers to question No. 6 and in most instances the items are in the words of the questionnaire returns. The percentage figures indicate the per cent which the accompanying figure is of the total number of that class answering this question. (Totals here cannot be checked with totals in other tables because here some give more than one answer).

	Male	Female	Total
1. Suggestion: Books, stories, etc., and the hearing and seeing of actual instances of foster parentage.	30 (43%)	66 (46%)	96 or 45%
2. Dissatisfaction: Limitations of home, longing for wealth, discontent.	1 (1%)	9 (6%)	10 or 5%
3. Mistreatment (Actual or supposed): Harshness, partiality, teasing, fault finding, inconsistent treatment, desire for affection, lack of respect for parents.	19 (27%)	34 (24%)	53 or 25%
4. Peculiar Family Circumstances: Prolonged absence from parents, parental disagreement, great difference in children's ages, family quarrels, previous marriage of one parent.	2 (3%)	5 (3%)	7 or 3%
5. Accidental Causes: Parent misunderstanding child, misunderstanding of adult remarks.	1 (1%)	3 (2%)	4 or 2%

	Male	Female	Total
6. Activity of Mind (Instinct to think): Precocious philosophizing, mere play of imagination, much alone, nothing to do.	11 (16%)	16 (11%)	27 or 13%
7. Growth Stimulus: Early adolescent development, desire for the different.	1 (1%)	2 (1%)	3 or 1%
8. Absence of family resemblance, mental and physical.	3 (4%)	13 (9%)	16 or 7%
9. Miscellaneous: Praise with ulterior motive, self pity, lure of elsewhere or of the wild, mood, circumstances, desire for older brother, vivid dream.	7 (10%)	2 (1%)	9 or 4%
10. Unable to recall.	5 (7%)	13 (9%)	18 or 8%

Of those giving affirmative answers to question No. 3, 214 or 83 per cent answered this question. Of these, 70 were males or 80 per cent of the males answering question No. 3; and 144 were females or 84 per cent. In only two instances is there a noticeable difference here between the sexes. Absence of family resemblances seems to be more significant for the girls and there is a similar preponderance of boys in the group called mental activity or the manifestation of the instinct to think. In passing it is interesting also to observe that all of the ten cases under dissatisfaction had ideas of greatness in their fantasies. This will be discussed further in the next section.

RELATION OF FANTASY FORMS TO CAUSES GIVEN

Observing almost as many reporting notions of inferior parentage as there were of those reporting ideas of greatness, with other indications of developmental stages of the fantasy already mentioned, it seemed possible that a segregation of the causes which each of these groups offered might also be productive. The results of this segregation appear in the following table:—

	Orphan or Foundling Group	Ideas of Greatness
Suggestion	19 or 58%	12 or 30%
Dissatisfaction	0	10 or 25%
Mistreatment	5 or 15%	6 or 15%
Miscellaneous and Indefinite	9 or 27%	12 or 30%

The most conspicuous thing appearing in this comparison is the complete absence of dissatisfaction causes in the "orphan group" and its emphatic presence in the "greatness group." Mistreatment is about equally influential in the two forms of the fantasy, and suggestive causes are given much more frequently for explanation of the fantasy by those in the "orphan group" than by those in the "greatness group." For help in grasping the meaning of these likenesses and differences reference should be made to the presentation of data concerning the forms of the fantasy. There will be found indications of stages of development, as was also suggested in the answers to the question concerning belief in the fantasy. Following this suggestion of a developing fantasy the table just presented would seem to indicate that mistreatment and suggestion first give rise to the idea of foster-parent-hood which early takes the form of orphanage or inferiority of some sort, perhaps assisted by feelings of helplessness or inferiority in the face of supposed ill usage or partiality for other children. Then with the continuation of the fantasy, growth and the vigor of approaching adolescence come ideas of greatness, doubtless again assisted by the suggestive causes mentioned, and reflection on these ideas of greatness might be the reason for the appearance of the alleged dissatisfaction causes in the "greatness group," the disatisfaction thus being more consequence than cause. This seems much more likely than the ideas of greatness should come first and with continuation of the fantasy the dissatisfaction disappear. Comparison with the complete table presenting all causes alleged will show all dissatisfaction cases are found in this table correlated with ideas of greatness, whereas only a small number of the suggestion cause cases in this study had ideas of greatness. Such a statement would be far from the truth for any of the other cause groups. It will be further observed that while the miscellaneous and indefinite group is a considerable percentage of the whole only a most improbable distribution of them, if more definite answers were obtainable, could alter the relationships between the groups.

Age to Which Fantasy is Attributed

(Answers to Question No. 7)

The following table presents the ages which 240 of the 258 people who had recallable experience with the fantasy mention as being the approximate time of its occurence:—

Ages	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Indefinite or No Answer	Total
Males	1	2	5	5	7	5	20	5	10	3	7	3	2	2	10	87
Females	5	8	10	11	28	18	26	7	21	11	6	7	3	2	8	171
Total	6	10	15	16	35	23	46	12	31	14	13	10	5	4	18	258

It will be observed that definite answers were obtained from 93 per cent of the group. Medians for both the male and the female distributions fall in the ten year group. This is undoubtedly too low because of the method used in tabulation. Some gave a definite figure, some said about a certain age and of course in these instances the figure given was used. But there were also many who answered in terms of an approximate range of years, as for example "About ten to twelve." Where this was done the tabulation was by the lowest figure given. Thus the actual measure of central tendency is higher than ten years, probably between ten and twelve years. Of course these are only rough approximations, but it must be remembered that most of these are approximations by young people not very far removed from the period in question, by young people still in their adolescent years (the median for the entire group studied being 18 years).

EFFECTS OF THE FANTASY UPON CONDUCT
(Answers to Question No. 8)

In this table are presented in summarized manner the answers to that question which sought to discover if any considerable number could recall influences of the fantasy upon their behavior, and in the event of there being such what the nature of the conduct effects might be. Of course the table is based upon the answers of those who had in response to question No. 3 indicated recallable experience with the fantasy.

	Male	Female	Total
No answer given	15 or 17%	27 or 16%	42 or 16%
No conduct effect recalled	55 or 63%	84 or 49%	139 or 54%
Some effect reported (See next table)	17 or 20%	60 or 35%	77 or 30%
Totals	87	171	258

It is worthy of note that this question was answered positively or negatively by 83 per cent of the males and 84 per cent of the females, or 84 per cent of the group reporting experience with the fantasy.

The 77 people or 30 per cent above who reported that the fantasy did have some effect upon their conduct, which they could recall, describe the effect in various ways but with sufficient clarity to make possible an effective grouping. It appears in the table following:—

NATURE OF THE CONDUCT EFFECTS

	Number	Per Cent
Deliberative thought, seeking proof, meditation, etc.	26	34%
Depressing emotional reactions:— Melancholy, embarrassment, fright, etc.	6	8%
Domesticating conduct:— Expression of greater affection for parents (1), conscious imitation of parents (1), improved conduct (1), more considerate conduct (2).	5	6%
Alienating conduct (from parents):— Teasing, tormenting, deceitful, disobedient, revengful, etc. toward parents (7). Stimulated independence of conduct, running away considered and carried out, or more self confident (9). Acting part of supposed real self (4) Reserved toward parents (4) Telling of the discovery (3) Seeking discovery by real parents (1) Deliberately acting in strange manner (1). Suspicious, sulky, saucy, snobbish, etc. (8).	37	50%
Miscellaneous (Poetic efforts, and disinclination to study).	2	3%
Positive but indefinite	1	—

The sub-topics in the table just presented are in most instances words and phrases taken directly from the questionnaire returns. In the recollection of these students the predominating effect of the foster-child fantasy upon conduct, or at least its conduct concomitant, is conspicuously that of alienation from the parents. This is of course in clearest harmony with the family romance generalizations of the psycho-analysts. The seeking of proof and meditative thought might be considered as a stage preliminary to the alienation in the fully developed phenomenon. So also the depressing emotional experiences reported. But the tendencies classed above as domesticating indicate a tendency in the other direction. Of course the writer is quite well aware that these may not be effects of the fantasy at all but merely growth concomitants, perhaps causing the fantasy. The writer is here merely seeking and presenting the opinions of his subjects.

As before, the return in the ''orphan group'' and the ''greatness group'' were then isolated and the answers each gave to the question concerning conduct effects was tabulated according to the rubrics just used in order that any significant group peculiarities might again be revealed. The result was as follows:

Effect Reported	Orphan Group	Greatness Group
Deliberative thought, etc.	6 or 18%	2 or 5%
Depressing emotion	2 or 6%	....
Domesticating conduct	3 or 9%	....
Alienating conduct	7 or 21%	13 or 32%
No conduct effect reported	13 or 40%	17 or 43%
No answer given	2 or 6%	8 or 20%

The great difference between the percentages of the two groups giving no answer to the question makes any generalization from the other differences hazardous. The other differences suggest, however, a trend away from deliberative thought, depressing emotion and domesticating conduct (early stages perhaps of the fantasy) toward alienating conduct.

DURATION OF THE FANTASY BELIEVED

(Answers to Question No. 9)

People answering the questionnaire who had actually believed themselves to be foster children were asked to indicate as nearly as possible how long the belief continued. The following table summarizes their estimates:

	Male	Female	Total	Per cent
No answer or too indefinite for use	4	8	12	17%
Very brief time (few minutes to few days)	6	11	17	24%
''Three months,'' ''four months,'' or ''few months.''	2	5	7	10%
About one year	2	4	6	8%
About two years	1	13	14	20%
About three years	1	6	7	10%
About four years	..	3	3	....
About five years	..	1	1	....
''Several years''	..	3	3	....
About fifteen years (prolonged separation from parents).	1	..	1	....
Totals	17	54	71	

Some indicated in their answers that the belief was intermittent by the phrase ''off and on'' for the time specified. The long duration of the believed fantasy is a little surprising. Thirty-five or forty-nine per cent think the belief endured for a year or in some cases much more. It is also of interest that the question was answered in a specific manner by 83 per cent of those reporting belief in the fantasy. Generalizations from these figures would, however, be unreliable because of inconsistencies in reporting. The experience was apparently spasmodic or recurrent with many; and in answer to this question some gave an estimate of the period within which these recurrences came, while others gave merely the approximate duration of a single occurrence.

DISAPPEARANCE OF THE BELIEF

The tenth question revealed that as a firm belief the fantasy had disappeared in all cases; although two or three report a lingering influence well described in the phrase of the one who said, "At times it seems to haunt me."

The second part of the question asked why the belief had disappeared, of course seeking the opinion of those answering. The answers to this appear in the following table:

REASONS GIVEN FOR DISAPPEARANCE OF BELIEVED FANTASY

	Male	Female	Total	Per cent
Growth and development of intelligence, recognition of absurdity of belief, discovery that others had experienced the same thoughts.	9	24	33	46%
Parental intimacy (parental confidence, assurance and explanations and parental affection).	4	17	21	30%
Discovery of proof (Observation of family resemblances, discovery of records, etc.)	..	12	12	17%
Miscellaneous (One vague answer, one where aspects of belief failed to materialize).	..	3	3	....

The numbers in this table refer to the number of times each reason was mentioned. As some were mentioned more than once the numbers will not of course check with the other tables. The percentages are based on the number who believed their fantasy, that is 71. This question was answered by 83 per cent of them in a definite manner. The others did not answer or said they were unable to do so.

COMPARISON WITH RESULTS OF PSYCHOANALYSES

That inquiry of more than nine hundred young people should reveal 28 per cent who could immediately recall experience with the foster-child fantasy supports the Freudians at the outset. To this number ought of course to be added all those who could immediately recall the experience, those who had it and with whom it is now beyond even mediate recall (instances of which with adequate proof have come to the writer's attention aside from those here studied), and those in whom it may have suffered a psychoneurotic suppression. Of course such an addition cannot be made in terms of figures; but the mention of such cases indicates the minimal nature of the twenty-eight per cent discovered by this study. Thus considered the number is sufficiently large to warrant the assertion that it is a common experience of childhood. So far the psychoanalytic generalization has been justified. And a more definite statement can now be substituted for Rank's that ''many persons . . . very frequently remember occasions of this (foster-child) kind.''

From psychoanalytic studies the foster-child fantasy was located in the pre-adolescent years (Freud's period of sexual latency or Jung's pre-sexual period). The two hundred and fifty-eight young people found in this study to have had recallable experience with the fantasy located it in the same period of development. The median of the answers given fell between the ages of ten and twelve years. The years eight to twelve inclusive covered 61 per cent of the answers.

Taking Rank's oft quoted statement of the course of the family romance as the authoritative presentation for the psychoanalysts one finds in addition to the basic parental detachment motive of the romance the mention of two immediate causes of the foster-child fantasy, feelings of parental neglect or lack of affection and romantic literature. These two immediate causes have been amply verified by the results of this study. They were the two causes most frequently mentioned by these young people. But there has also been brought to light certain other supplementary causes, not mentioned by Rank, which in the minds of these sujects are of some importance. They are prolonged absence from the parents, marital infelicity observed by the children, precocious philosophizing, lack of companionship and the absence of mental or physical resemblance to the parents. The last is of peculiar interest not only because it is so common a topic of discussion before children but also because the subsequent development of family resemblances is several times mentioned in these returns as a cause for the decline of belief in the fantasy. One of those who had never experienced the fantasy remarked that ''the reason I have never acquired such a notion is the fact that all my life every one has spoken of the great resemblance I have for my father.''

Rank presents the fantasy as undergoing development from an early stage in which the child thinks of himself as an adopted or step-child to the higher stage characterized by expansive ideas, variously elaborated according to the child's adroitness and the material at his disposal. This questionnaire study not only supports but also considerably elaborates the psycho-analytic conclusion. All through the returns there are indications of the developmental stages of the fantasy. Concerning the forms of the fantasy there were those, a large group, who had but the vaguest if any idea beyond the thought of foster-childhood, some saying that they had never thought further than that. Then there were those who reported thinking themselves as different characters at different times. The apparent relationship of the different form groups (incipiency, orphan, same social status, great parentage, supernatural being) suggests the same thing. The relationship of forms to causes carefully tabulated indicated the developmental interpretation of the fantasy as the only feasible explanation of the otherwise strange distribution of causes mentioned. The relation of the forms to the reported conduct effects pointed, if less clearly, in the same direction. Examination of the conduct effects indicated stages from meditation on a more or less fascinating idea to decidedly alienating conduct. Degrees of belief also appeared very clearly in the answers given. Even without knowledge of the psychoanalysts conclusions it would have been difficult if not impossible to have interpreted this data otherwise. And the conclusion is in harmony also with the known traits of childhood imaginative fancy as well as the growth of delusions in paranoia.

The forms of the fantasy named herein revealed not only the two mentioned by Rank but also another equally prominent, that of inferior parentage, which seems to lie between the two because it has a definite form and the incipient stage lacks definition. The few cases of fantasies of parentage of similar social status hint at another intermediary stage, decidedly harmonic with the concept of an outward tending libido, which might follow the inferiority stage. And the few cases of those who conceived themselves as of supernatural or very mysterious nature might point to a still higher development of the fantasy, rising to heights above mere concepts of worldly greatness as in paranoid delusions. If true this might be of much interest to those attempting to apply psychoanalytic concepts to the interpretation of the founders of religion. But the writer is far from confident that the last two are genuine stages in the development of the fantasy. The number of cases is small and they might prove to be merely circumstantially conditioned variants from the normal course. For the inferiority stage, however, in which the child thinks of himself as a foundling or poor asylum orphan, following the earlier or incipient stage in which there is no concept beyond the thought of foster-childhood, there is sufficient evidence in the data presented. Of course the demonstration of a stage in the course of the fantasy characterized by inferiority concepts immediately reminds one of Adler, and it might be that ideas of greatness develop as compensations for these inferiority concepts which doubtless are accompanied by feelings of inferiority.

In considering the forms of the fantasy it is interesting to notice Rank's statement concerning the sources of the ideas of greatness. He says: "The child utilizes an accidental coincidence of actual happenings (meetings with the lord of the manor, or the proprietor of the estate, in the country; with the reigning prince, in the city. In the United States with some great statesman, millionaire)." (5 page 65). To the writer there is in that quotation the implication that in this country the fantasy is less likely to take the form of royalty or nobility. Perhaps this is so, but as a matter of fact eleven of the forty cases of expansive ideas, here studied were found to have the form of princes, kings or nobles. The appeal of non-democratic institutions is apparently not dead in the minds of American children.

As has been so often presented in the psychoanalytic literature, the principal motive of the family romance is the progressive detachment from the parents. Rank points out that revenge and retaliation motives also appear in the course of the romance, but considers them as stimuli for further imagings, further developments of the fantasy. The progressive detachment from the parents was clearly indicated in the writer's returns from those who recalled changes in conduct at the time of the fantasy. Many mentioned much thought about the matter and the deliberate seeking of proof for their notions, some wrote of depressing emotions as the consequence of their fantasy, a still smaller number state that they were moved to better behavior and greater affection for their parents (a domesticating tendency), but by far the larger number reported instigation to conduct which would inevitably alienate them from parental influence. The general direction of the conduct effect (or concomitant conduct) was clearly away from parental authority in the recollection of these adolescents. The few who mention a domesticating tendency may indicate a slight hesitation to take the plunge into independence, a slight oscillation at the outset before fixation of growth direction is established. The many reports also of revengeful and retaliatory conduct, the conscious tormenting of the parents, harmonizes perfectly with Rank's statements.

In fine this study seems to have resulted in an amplification as well as a justification of the results of psychoanalytic investigation. Psychoanalytic conclusions concerning the foster-child fantasy have stood the test of checking by a different method of research. At the same time it throws doubt upon the statement of Rank that the psychoanalysis of psychoneurotics is the only tool by which the imaginings of childhood may be studied (5. page 63). It is possible that the questionnaire might by itself never have discovered the foster-child fantasy and the family romance, but this study has demonstrated its usefulness as a tool for the checking of the results of psychoanalytic study and also for their amplification. Rank has compared psychoanalysis with empirical observations, but the questionnaire as used here is not empirical observation. It approaches in its request for free personal recollection much nearer to the anamneses of psychoanalysis and has the advantage of being able to bring data readily from numbers large enough to permit of statistical treatment.

SUMMARY AND CONCLUSIONS

The foster-child fantasy has been demonstrated to be a common experience of childhood. Twenty-eight per cent of the 904 returns here tabulated could immediately recall experience with it.

Twenty-five per cent of those who reported experience with the fantasy (7.8 per cent of all) believed in it as a correspondence with facts. The others expressed many varieties of attitude from partial belief to none at all.

Three stages of development of the fantasy were indicated. In 54 per cent the fantasy had never taken any definite form, 15 per cent thought of themselves as poor orphans or foundlings, 18 per cent had developed ideas of greatness. Two other stages were suggested in the returns but by numbers too small for generalization.

Suggestion (45 per cent) and supposed mistreatment (25 per cent) are most frequently given by those questioned as causes for the fantasy. But other causes, although less frequent, were indicated sufficiently often to deserve consideration; precocious thinking (13 per cent), lack of physical or mental family resemblance (7 per cent), and dissatisfaction with home conditions (5 per cent).

The fantasy is located by more than half of those reporting in the period of 8 to 12 years of age.

The most common effect of the fantasy recalled, as described by these subjects, is conduct alienating them from parental influence and authority.

The duration of the fantasy for those who had actually believed themselves foster-children was reported to be more than a year by 49 per cent (maximum 15 years). It was reported as of very brief duration by 24 per cent, and as lasting a few months by 10 per cent.

Growth and the development of intelligence is most often mentioned as the cause of the removal of the fantasy among those who had believed in it, but there are two-thirds as many mentions of parental intimacy and a smaller number reporting discovery of convincing proof, such as physical or mental similarities and actual records.

Comparison with the psychoanalytic presentation, especially that by Rank, results in both support and amplification of the generalizations from psychoanalysis. The frequency of the fantasy, the age location of it, causes given, two stages of its development, and the progressive detachment from the parents are alike in the results from both methods of study. The questionnaire method has, however, added the discovery of other causes, another stage in its development, some modification of statements concerning sources of the fantasy forms, and has revealed itself to be a serviceable supplement to psychoanalysis.

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THE SYNAESTHESIA OF A BLIND SUBJECT

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The twofold purpose of this paper has been to report a very complicated case of synaesthesia and allied phenomena in the waking consciousness of a blind reagent and to review the literature on the subject of synaesthesia.*

Among the vast number of individual cases of synaesthesia which have been described in the literature there are to be found only a few reports of such secondary sensations in the blind. Fechner (41) discovered colored hearing in two subjects who had become blind. In 1892 Starr (127) described three cases of synaesthesis which he found among twelve pupils at the State School for the Blind in Iowa. Colors were here associated with tones, letters, digits and proper names. He tested these subjects over long intervals and found that their color associations were permanent. In 1893 Phillipe (109) found thirty cases of synaesthesia among one hundred fifty pupils in different institutions for the blind. These cases were all forms of colored hearing. He discovered that the colored associations varied according to the methods by which the pupils were trained or taught, particularly in literature and music. The synaesthesia also varied with different degrees of blindness. Only two of the thirty subjects could recall that their colored hearing began before they lost their sight. With only a few exceptions the remaining subjects were certain that their secondary sensations developed subsequent to their blindness. In cases where letters were colored, the point alphabet and not the Latin alphabet was usually the stimulus which evoked the colors. Where tones were colored, the brightness of the secondary sensations was determined largely by the pitch of the tones.

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*In endeavoring to fulfill this latter purpose it was necessary to borrow much of the literature. The review is not complete but the writer believes that a majority of the more important articles have been covered in the review. He wishes to express his gratitude to Mr. M. H. Douglass, librarian at the University of Oregon, and to Mrs. Mabel E. McClain, whose assistance proved invaluable in obtaining literature which was unavailable here.

The frequency of twenty per cent which Phillipe found to prevail among the blind is somewhat higher than the frequency of synaesthesis among the seeing, for among the latter, the average estimate has been fifteen per cent. Phillipe suggested that this greater frequency of colored associations among the blind than among sighted people might be due to the fact that the blind, who have formerly seen and have recognized colors, make constant efforts to retain their imagery of these colors. Since visual sensations have been eliminated, they are obliged to associate colors with experiences from sense fields other than the visual. It is interesting to note that Phillipe failed to discover any synaesthesis among pupils who were deaf. Although he did not carry this part of his investigation far enough for conclusive results, the lack of synaesthesis among the deaf, if true, would be consistent with the fact that most of the forms of color associations of this kind are of auditory origin. Flournoy (44) made a contemporary investigation of twenty-five blind subjects and found one case of colored hearing, six who had number or other forms, and one who had a marked case of ''personification.'' Coleman (26) observed a case of colored hearing in a subject who had lost his sight at the age of five years, after the synaesthesis had already developed. After blindness appeared there were no marked changes in the colors.

One of the earliest obtainable records of synaesthesis was made by Hoffman in 1786 (63). In this record was described the case of a Swiss magistrate and painter who had numerous varieties of colored hearing. No attempt to thoroughly investigate the case appears to have been made. Another early mention of colored hearing is to be found in Goethe's ''Theory of Colors'' (53), published in 1810. In 1812 Sachs (120) described a very interesting case of an Albino whose synaesthesis included colored vowels, consonants, musical tones, digits, cities, days of the week, dates, epochs in history and certain abstract terms which had to do with phases of human life. Sachs attempted to treat the problem systematically. In his classification of different forms of synaesthesis into acoustic, optical and psychological, according to their origin, we find a very early and noteworthy recognition of both a physiological and a psychological problem in the phenomenon of secondary sensation.

In 1843 Gautier (52) reviewed his own case of colored hearing, which he found could be stimulated artificially by means of hasheesh. The problem was attacked in 1848 by the oculist, Cornaz (31), who thought that in colored hearing he had found a form of Daltonism similar to color-blindness and subject to the same laws of heredity. Accordingly, he attributed this form of synaesthesis to a hyperaesthesia of vision. In 1859 Ehlert (37) described his own associations of color with music. The next year, 1860, Marcé (89) attributed synaesthesis to an optical defect, as Cornaz had done. In the same year Vauthier (140) described his own case, a very peculiar feature of which consisted of the act of associating severe tooth-aches with tones of a certain pitch and quality.

In 1863 Perroud (107) attacked the current view that colored hearing was pathological, and substituted the view that the laws of association would adequately explain the origin of such phenomena. This conclusion he derived largely from the details of his own case. The pathological view was again attacked in 1864 by Chabalier (23) on the ground that the view could not be substantiated, and for the further reason that he believed synaesthesis to be due to a confusion of ideas or to a psychic perversion. How else could be explained the fact that in his own case letters were colored so vividly that their meanings entered consciousness only after the colors had appeared? Or how was it, otherwise, that he often forgot proper names but never forgot their corresponding colors? For Chabalier, therefore, colored hearing was nothing but an illusion!

In 1871, Rause (115) reported a case of synaesthesis which was apparently associated in a most remarkable way with a gunshot wound in the lungs. The subject in question had been struck by the bullet in the spina scapulae and had sustained a second exterior wound in the first intercostal space, where the bullet had found its exit. When a weak solution of lactic acid was poured into the anterior wound the subject could taste the liquid. This accidental discovery lead to several very careful tests in which every precaution was taken in order to eliminate the influence of smell and of suggestion. Under these latter conditions, even when the subject had no warning of the stimulus, he tasted weak solutions which were poured into the anterior wound. In fact the patient was able to judge the strength of the solution fairly accurately by means of the intensity of the concomitant taste. Similar tests in the posterior wound failed to arouse any taste sensations.

In 1873 J. A. Nussbaumer (103) reviewed his own case of synaesthesia and also his brother's case, both of which were very complicated and both of which began at the age of four or five years. At this early period in their lives these two brothers argued and fought between themselves as to the colors which they thought belonged to the tones of certain musical instruments. Later, one of the brothers noticed that these same color associations accompanied auditory images in his dreams. Certain peculiarities of the photisms were noticed by the other brother, among which was the localization of his colored photisms either against the forehead or immediately in front of it, instead of in the direction of the sound, as is more frequently the case. He also noticed that at times he could listen to lengthy concerts without the appearance of any colors, while isolated tones were always colored. Nussbaumer attempted to throw light upon the origin of colored hearing by observing the possible effect on the photisms of passing weak electric currents through different portions of the brain. Only negative results were obtained beyond the fact that the current caused faint flashes of color to appear when it was passed through the forehead between the temples! Although this investigation offered no solution to the problem, it stimulated a considerable amount of literature on synaesthesia, first, perhaps, because of its thoroughness as far as it went and secondly, for the reason that it gave an opportunity for further theoretical speculation. Here the origin of the phenomenon could be traced beyond a doubt to early childhood and here, also, the colored hearing undoubtedly depended upon auditory stimuli.

In 1876, Nuel (102) tried to explain the Nussbaumer cases from a physiological point of view by attributing the phenomena to a deterring of afferent nerve currents from their usual course to areas of the brain adjacent to their normal terminus. After these currents reached the adjacent area they aroused some form of molecular disturbance, eventually giving rise to false sensations. In the same year Fechner (40) published the results of an investigation of about three hundred individuals who possessed some form of synaesthesia. The chief purpose of this study was to discover a possible objective basis for the secondary sensations. He failed in this attempt and continued his study of the problem by resorting to statistics and the questionnaire method. Here again he found too many exceptions to every rule, and his attempt to find the origin of synaesthesia brought negative results.

Pouchet and Taurrieux attempted to explain colored hearing physiologically in 1878 (113), and introduced the view that colored hearing was a result of abnormal crossings and unitings of afferent fibers. The writers upheld their conception by a reference to the Helmholtz theory that each fiber of an afferent nerve determined a sensation of specific quality. Pedrono (106) attacked this view on the ground that too many fibers would have to cross one another in order to account for the many individual colors which accompanied numerous tones of varying pitch and quality. In 1881 Bleuler and Lehmann (16) devoted a monograph to a detailed study of synaesthesis in its various known forms and described a large number of new cases. Among the latter was one in which acute angles were always a very light grey; obtuse angles were the opposite; wavy lines were a very dark shade of green; circles were bright yellow; triangles were silver; and rectangles were light grey. Here we find a case of synaesthesis which was evidently dependent upon optical stimuli. In the same monograph were described instances of colored tastes, colored odors, and colored tactual sensations. By resorting to a statistical study of large numbers of cases, the authors tried to find a clue to the origin of synaesthesis, but they were no more successful than Fechner had been. The following are their more important conclusions: (1) The colors of words and letters are not always dependent upon the sound but often upon their meaning; (2) bright photisms are invariably associated with tones of high pitch, with intense pain, or with punctiform or sharp pressure sensations; (3) dark photisms are associated with tones of low pitch, with blunt pain and pressure sensations; (4) according to their frequency of occurrence the reds, yellows and browns come first, followed in order by blue, violet and green; (5) approximately twelve per cent of normal individuals have some form of synaesthesia and the phenomenon is rarely found among the insane; (6) many cases of synaesthesia are probably inherited; (7) these facts lead to an association theory.

In 1881 Kaiser (72) supported the association view of Bleuler and Lehman, and supplemented it with the suggestion that many subjects make a voluntary effort to improve their memory while they are young by associating colors with sounds, letters, words and the like. In the same article Kaiser reported a peculiar case of synaesthesis in which German words were green, English words were brown, French words were a very dark brown and Greek words were yellow. In 1882 Pedrono (106) noticed that the colors which were associated with musical sounds were localized very differently by different individuals. Colors might be localized above the person who was singing; they might be suspended in mid-air above the sounding instrument; or they might be localized in space directly in front of the subject. Pedrono also observed that when the object making the sound was not visible to the subject or when the subject closed his eyes, the colors were localized in the direction of the sound. When the subject was placed in a dark room and the sound was carried to him by means of rubber tubes, the colors were seen in their usual vividness and in their usual localization. In his own case of colored hearing not only did the objective sounds arouse colors, but images of those sounds as well.

In 1883 Galton collected a considerable amount of data on various forms of synaesthesis (49) from which he concluded that vowels were more likely to be colored than consonants, and that most types of synaesthesis were inherited. He was perhaps the first to point out that number forms and synaesthesis frequently go hand in hand, that is, many number forms possess permanent colors as well as permanent shapes and outlines.

In 1883 and later in 1888 Baratoux (5, 6, 7) advanced the view that colored hearing might depend upon an anastomosis of brain centers or of fibers leading to the brain from the organs of the senses associated in synaesthetic fashion. He believed that this anastomosis was to be found to a certain extent in all individuals and that all persons, therefore, had some form or degree of synaesthesis, no matter how slight. In 1884 Lussana (86) ventured the further suggestion that those brain centers lying adjacent to one another might be so connected by nerve paths as to render reciprocal aid in such physiological activities as underly the process of perceiving.

A series of investigations was begun in 1885 by Holden (64) and continued at intervals until 1906 (65, 66, 67, 68) with his daughter as the subject. Her synaesthesis was tested at the ages of seven, eight, ten, fourteen, seventeen and twenty-one. During this time the only changes that had occurred in the colors were the shift of cream to white as the associate of the digit 8, and the shift of brown to black in the color associated with 10. Twenty-four years after the first tests had been made, colored letters, digits and days of the week had undergone only very minor changes in their brightness qualities.

In 1885 and 1886 Lauret (78) published data on several individual cases, including the interesting variety of colored hearing in which the letter "A" was a black oval with a perpendicular axis; "E" was a square of muddy straw-yellow, and so on. In 1885 Rochas (117) described a form of colored hearing in which the colors were not externalized, but were localized on the subject's brain. Words and letters of different languages were colored uniformly according to the language. Low tones were very dark or nearly black and as the tones varied upward in pitch the associated colors passed through the hues of the spectrum in regular order, beginning with red.

Feré (42) rejected the view of anastomosis or tangling of fibers and substituted the view that the nervous system has a certain "tone" which renders it amenable to synaesthetic results either with normal stimuli such as sounds, letters, words and the like, or with abnormal stimuli, such a drugs. In 1887 (128) Steinbrügge suggested that synaesthesia began in early childhood as a direct but double perception, or as a primary perception accompanied by a sub-perception. The sub-perception could not be due to association for the reason that the colors appeared too suddenly upon the perception of the sound or letter, leaving no time for the forming of associations. He resorted, therefore, to the physiological conception of anastomosis of fibers and to the resulting deterring of excitations from their usual channel to areas of the brain adjacent to the normal terminus of such excitations. The author seemed to favor the association theory, however, in explaining certain forms of permanence in colored hearing.

In 1888 Urbantschitsch (136) found that catarrh of the middle ear or a defect in the outer ear might, in certain instances, influence the patient's capacity to see and that stimulation of the eye or of the ear might facilitate the functioning of the other organ. These facts lead the investigator to conclude that he had found another variety of synaesthesia which appeared under entirely new conditions. Further experiments showed that this mutual influence between the functioning of the eye and the ear could be studied under experimental conditions. Among certain subjects he found that the perception of a tuning fork might be changed both in intensity and quality by light stimuli when the latter were presented simultaneously with the sound. It is a question, however, if attention did not have something to do with this result. In one subject, spots and streaks of grey appeared on a sheet of paper when a tuning fork was sounded. Another subject found the paper to take on a reddish tint under the same conditions. Still other subjects appeared to see other colors on the paper. Such results were not obtained with observers who did not possess colored hearing. These results lead Urbantschitsch to conclude that the peculiar response which he obtained in one sense field when another sense field was being stimulated was due to a peculiar form of reflex. This view he expanded, theoretically, to cover all forms of synaesthesis. More recent studies of the conditioned reflex made it seem plausible that the phenomenon which Urbantschitsch was dealing with might have been a form of the conditioned reflex.

In 1890 Mendoza (95) reviewed two interesting cases of a brother and sister who had colors for tones, for musical compositions and for composers' names. For one of the subjects, Hadyn's music was green, Mozart's was blue, Chopin's was red and Wagner's was cloudy grey. Auditory imagery of these compositions aroused the appropriate colors as well as the actual music itself.

In the same year Raymond (116) found clinical evidence, he thought, of a very close anatomical and functional relation between those brain centers which functioned in synaesthesia. There seemed to be unusual nerve connections which linked one of these areas with the other. In the same year, also, Spencer (125) reported a case of synaesthesia in which vowels were colored and in which words were colored according to the vowels which they contained. In those words which had more than one vowel, the accented syllable or a dominant vowel determined the color. In 1891 Jordan (70) described his own color associations which bore many resemblances to the case just previously mentioned. In addition, there seemed, in Jordan's case, to be a peculiar inconsistency in the color associations, for the word *red* was green and the word *blue* a different shade of green. The letters or words themselves did not assume the colors but were visualized on a colored background. Jordan accepted an association theory of colored hearing for the reasons: (1) in his case and in many others, the vowel "I" was black or very dark, due perhaps to the fact that "I" is a black line; (2) the vowel "O" was white or very light, due to the fact that in this letter there was a white space surrounded by the outline of the letter; (3) in many instances it happened that the color of a favorite letter was a favorite color. The difficulty with this method of explaining color associations is to be found in the impossibility of applying it to more than a few isolated cases. Jordan's own observations verified those made by Spencer in that the color and the shade of the letters depended in part upon their form, in part upon their sound and in part upon their meaning.

A very valuable and extensive review of the literature on synaesthesia was published in 1891 by Mendoza (96). In 1889, 1892 and 1893 Grüber (55) reported several remarkable cases of synaesthesia, some of which proved of great advantage to the subjects. In one instance so faithful were the associations of colors with digits that the subject was able to perform mathematical operations by means of colors. In this respect this case resembles the one which will be described later by the present writer. In another instance a singer was able to judge the accuracy of pitch by means of the fine differences in shades and tints of his colored tones. Another subject was able in the same way to change the quality of his voice to a very minute degree. Grüber employed the method of measuring projected photisms with a millimeter scale in order to determine the constancy of the colors over long periods of time. His subject in this experiment was a Roumanian who associated colors with digits and diphthongs. The names of the digits were presented to him in the Roumanian language for the reason that his colored hearing was acoustic in origin. The subject was asked to project his photisms upon a white cardboard. The photisms themselves were either circular or oval in shape. The cardboard was surrounded by a colored background and the size of the white interior was varied until the limits of the projected photism corresponded exactly with the limits of the white cardboard. For example, the digit "2" was associated with a bright yellow circle. The central cardboard was made in the form of a disc the same shape as the photism. When the subject was asked to project his yellow photism upon the white disc, and the disc was surrounded by a red background, if the disc was too large for the photism there appeared around the edge of the photism, between it and the red background, a band of white, where the disc extended beyond the limits of the photism. If the disc were too small, there appeared on the red background just around the disc a band of orange where the photism extended beyond the limits of the disc and onto the red background. When both the orange and the white bands failed to appear the experimenter knew that the size of the white disc and the size of the photism exactly corresponded. Many of the photisms were oval rather than circular. When different digits were presented to the subject in serial order and according to their value, the vertical diameter of the oval increased with the addition of every syllable in the name of the number. The horizontal diameter of the photisms increased with the addition of every cipher. The diameter of the photisms of the units class was twenty-one millimeters; the photisms of the tens class were twenty-three millimeters in diameter; the hundreds class were twenty-six millimeters; the thousands class were thirty millimeters; the hundreds-thousands were forty-one millimeters; the millions class were forty-eight and so on. If each of these diameters be substracted from the one previous the differences will read two, three, four, five, six, seven and so on. This remarkable relationship held between the differences in the diameters of photisms of numbers as high as the billions class. A further remarkable feature of this subject's photisms was the fact that one dimension grew vertically and depended upon the phonetic element of the name of the digit; the other dimension grew horizontally and depended upon the arithmetical element or class to which the number belonged. Both diameters increased in the same proportion.

In 1892 Schooling (121 a) suggested the creation of a new art —color music. He evidently obtained his idea from reading Grüber's description of synaesthesia. The instrument for this new art was intended to be an electrically operated "color-organ," provided with a set of vacuum tubes which could be illuminated, giving various successions and combinations of colored lights, controlled from an ordinary key-board. How successful the experiment was we are not told.

In 1893 Flournoy (44) published the results of an extended questionnaire. Two thousand six hundred circulars were sent out six hundred ninty-four of which were answered and returned, giving a total of three hundred seventy-one cases of synaesthesia. From a study of these cases the author concluded that the principle of association offered a better explanation of most forms of synaesthesis, rather than a physiological theory. In many instances the colors were obviously due to associations which had been formed between the tone, digit or letter and the color equivalent and also between an affective or emotional process and the color.

The affective process was often common to the tone, digit or letter and the color of the photism. In this way favorite colors were apt to become associated with favorite tones, letters and the like and unpleasant colors might be associated with unpleasant tones or letters. Flournoy classified the different kinds of synaesthesis, according to their mode of origin, into: (1) habitual associations which were the result of simultaneous perceptions of color and sound; (2) privileged associations, or those whose practical value to the subject had lead to their frequent repetition and subsequent fixity; (3) feeling associations, which were due to the fact that letters and tones aroused the same affective processes as did the colors. In the same monograph this author described the colored hearing of a painter who frequently secluded himself with his violin in order to find colors for his paintings in the visual equivalents of his music.

The association theory received another adherent in 1893 in Stevens (130) who attempted to show how color equivalents might be formed in an indirect way. For example, in his case, the letter ''d'' was associated with ''dog;'' a certain black dog represented ''dog'' in general to him, hence the letter ''d'' came to be associated with black and always aroused that color. The letter ''v'' is the first letter in vulture, a brown bird, hence ''v'' came to be associated with the color, brown. But ''v'' is the first letter in violet. Why was it that ''v'' itself did not come to be associated with that color instead of brown?

Krohn published a history of the various theories of synaesthesia in 1893 and also described certain prominent cases in the literature together with one of his own observations (73). The subject on whom he made his observations was a young musician whose colored words, letters and digits were partly of acoustic and partly of associative origin. The colors depended both upon the sound and upon the meaning of the letters and digits. In certain instances the shape of the letters seemed to determine the color. Words pronounced alike but spelled differently had different colors. The colors of music were determined by the key in which the music was written. Curved letters were usually tan and straight lines were often red. From these facts and from details of other cases, Krohn concluded that certain forms of synaesthesis were undoubtedly due to the principle of association. On the other hand he conceded that the majority of cases could only be explained by a physiological irradiation between cortical centers.

A new method of attack upon the problem was made by Binet and Phillipe in 1892 (13) who employed the reaction method to determine the association time between letters, digits and the like and their corresponding colors. In the same year Beaunis and Binet (8) performed similar experiments and in the year following Binet and Phillipe (11, 110) published further results from the same type of experimentation, this time individually. In these series of experiments, which were made in the same laboratory at different times and on five different subjects, one method consisted of exposing to the subject a series of letters or digits to each of which the subject responded with the appropriate color. This was checked up by asking the reagent to respond with the first letter or digit which appeared in consciousness after the stimulus was perceived. The time required by the subject to finish the entire series was then divided by the number of letters or digits in the series and an approximate reaction time for each letter or digit was thus obtained. Another method consisted in presenting to the subject certain letters or digits in isolated fashion to each of which he responded with the appropriate color or with an associated letter or digit. The reaction time was obtained for each separate response and the average taken. In view of determining the subject's reaction type there were tried simple sensory and motor reactions, simple association reactions and choice reactions. No far-reaching results were obtained from these investigations. The time required for the appropriate color to appear after the letter or digit had been exposed was ascertained by subtracting the average reaction time in the letter-color and digit-color series from the reaction time of the letter-letter or digit-digit series. This gave a result of approximately sixty sigma.

In 1893 Thorp (133) reported his own colored hearing which proved to be of so great an annoyance to him in his music that he had to give up his musical education. In 1892 and again in 1893 Miss Calkins (20, 21) published the results of a questionnaire study of synaesthesis. In the first investigation five-hundred forty-three persons were questioned, among whom thirty-four had synaesthesis, including thirty-three cases of colored hearing, nineteen of colored names, thirteen of colored days of the week, seventeen of colored letters and three of colored alphabets. Galton's assertion that vowels are more frequently colored than consonants was not borne out. Word coloring could not be reduced to any formulae because at times the word took on the color of the initial letter; at times the color of an accented letter; or at times the color of the word was a mixture of the colors of the component letters. There seemed to be an indication that *i* and *o* were colored light and dark respectively, in many individual cases. In the second article results were published from a questionnaire which reached two hundred three subjects. This time there was found a far greater percentage of synaesthesis than was found in the former study. The author attributed this to improved methods of questioning and to a better preparation of her subjects for such questions as were asked them. Over one hundred different varieties of colored letters, digits, names, days of the week, noises, tones, composers and the like were found, and most of these associations were apparently fortuitous save for the colors of *i* and *o*. Again these latter were often dark and light. Miss Calkins sought to answer or throw more light upon the problems: (1) Do the colors of letters or of digits depend upon the sound or upon the meaning of the latter? (2) Do these associations depend upon a feeling tone common to the color and to the digit or letter? But no such uniformities among different individuals were found as would enable the investigator to form a general conclusion regarding either of these questions. The negative results might have been due to the fact that the subjects themselves were often unable to answer the questions upon which the results depended.

Out of the forty-five subjects who had colored words, twenty-seven had colored imagery of these words; in certain instances the words or letters themselves were colored but quite as often their colors appeared as backgrounds upon which the words or letters were superimposed, visually. In still other instances the words and letters were not visualized at all. There seemed to be no constant relation between the colors of words and the colors of component letters. The majority of cases of synaesthesis showed no tendency toward inheritance. It is not surprising, therefore, in the face of such a dirth of uniformities that generalizations were impossible. Among certain individual cases abstract ideas and personal traits were associated with colors. One case of "personification" was found in which certain letters had the following characteristics: *K* was a young woman, the friend of *L* and the daughter of *M; O* was a young nephew of *M; Q* was an eccentric middle-aged man; *R* was a clever admirer of *S* and so on.

Occasionally the subject changed the traits of these letters in a fanciful effort to keep harmony in her large alphabetical family. As a result of these two studies, Miss Calkins concluded that the following percentages were representative of the distribution of synaesthesia among individuals: Synaesthesia proper, fifteen per cent; number forms, thirty per cent and both together in the same individual, eight per cent.

A third investigation was made in 1894 (22) giving the results of two hundred cases which were studied over the interval of a year. From this number forty-three cases of colored hearing were found, together with seventy-two of colored words, sixty-three of colored music, fourteen of colored digits and numerals, six of colored tastes, six of colored pressure or temperature, one of colored pain and one of colored odors. Again the author collected evidence against Galton's statement that vowels were more often colored than were consonants. In this and her preceding articles she presented numerous tables indicating the relative number of cases in which synaesthesia was thought by the subject to depend upon (1) early formed associations, (2) upon a common emotional tone. The tables also included the number of cases in which the color associations proved to be an advantage or a disadvantage to the subject and the number of instances in which the colors were clearly or only dimly localized. These tables indicated that the association and emotional theories of the origin of synaesthesia held in a little over one-half of the total number of cases. They also indicated that the colors were usually distinctly localized and that the associations were generally of no particular value to the subject. Thus the method of arranging a large quantity of statistics in tabular form failed to produce any real positive results. The third article is valuable, however, for the reason that there is included a very elaborate questionnaire which was used in the two later investigations.

In 1896 Lay (80) reported three cases of synaesthesia in three sisters, aged nine, ten and twelve. No evidence was found that the color associations were inherited. All three sisters had colored alphabets, colored digits from one to twenty, colored proper names, days of the week, months of the year and certain other names. The associations dated back as far as the subjects could remember. In the same year Epstein (38) suggested a new variation of a physiological interpretation of synaesthesia. Auditory excitations generally follow their regular course to the auditory center of the brain but in certain instances some of these excitations might be deflected at the corpora quadrigemina where the proximity of visual and auditory ganglia is very close. From here the auditory excitations might pass over visual paths to the visual area of the brain.

A valuable discussion of synaesthesis was published by Hennig in 1896. In this paper (59) he classified secondary sensations as physiological and as psychological, according to their origin. The first group depended upon peculiar nerve connections and the second depended upon the formation of peculiar associations. That certain forms of synaesthesis were undoubtedly psychological in origin was borne out by the striking example in which a certain subject associated clarinet tones with the color, blue. At one time this subject was listening to a clarinet solo, while standing out of doors. As he was looking upward toward the sky, he became absorbed in the tones from the instrument, momentarily noticing at the same time that the blue of the sky was unusually rich and clear. From that time on clarinet tones aroused this same shade of blue. Of chief interest to this author was the practical value of many forms of colored hearing and for that reason a considerable portion of the article was devoted to this phase of the topic. He observed that poor spellers, who were at the same time synaesthetic, were occasionally helped by the colors which always accompanied different letters. Painters and musicians had recourse at times to their color associations in painting and in composing. Mathematicians sometimes used their color associations to good advantage in solving mathematical problems. On the other hand he found so few instances in which the secondary sensations were a positive disadvantage that he believed them to be an agent of superior mental endowment. He took the attitude that the associations should be cultivated by all individuals.

In 1897 Flournoy (46) described an elaborate and striking case of ''personification'' in a young man of nineteen. Names of the days of the week were dramatized as follows: Monday and Tuesday were a sad young man who held a fore-finger over one eye. This figure designated dark weather. Wednesday was a young man in the act of stealing an object behind him, bending over and extending his arms backward, between his legs. This figure also indicated dark weather. Thursday was a man in the act of turning a knob in the kitchen door on his way to the room beyond. Friday was a man in the act of selling from a wagon the object which was stolen by ''Wednesday.'' Saturday was a man in the act of falling against a door for the sake of amusement. This figure meant clear weather. All the figures were lacking in color but were definite in outline and especially in facial expression. Certain words were colored and others were dramatized. ''Autumn'' was the same man who represented Monday and Tuesday; ''Battle'' was a large woman seated at a little bench near a table, laughing. ''Shark'' was a large horse which stood near a load of hay. Whenever the subject saw or heard the word ''shark'' this imagery appeared in consciousness before the meaning of the word or before there appeared in consciousness the idea, fish. The tendency to form these associations reached its maximum when the subject was between eight and ten years of age and rapidly declined after the age of twelve. In his earlier life these personifications had been so marked as to dominate consciousness and to require voluntary effort to eliminate them. The subject had always possessed an unusually vivid imagination and he constantly anticipated the subject matter of a conversation or of a book, by means of vivid visual imagery. The remarkable ease and rapidity with which images were linked with words either voluntarily or involuntarily, relevantly or irrelevantly, seemed to be a peculiar trait of the subject's mental make-up. This trait lent itself readily to the development of personifications. It is possible that here we have a case which might be taken as evidence of Ferè's view that synaesthesis depended upon a certain ''tone'' of the nervous system. In this instance the ''tone'' might consist of an unusual elasticity of the nervous system, or a like condition.

In the same year Grafé (54) suggested that by making use of colored hearing and like phenomena, the blind could be made to see and the deaf to hear. But the suggestion has never been carried out! In 1898 Clavière (25) made an effort to standardize the various terms which were used to designate different forms of synaesthesis. He also reported instances of colored hearing in poetry and prose writings. His review of the subject of synaesthesis covered nearly all the current theories. In 1900 Whipple (144) made a series of tests upon two subjects who had highly complicated forms of synaesthesis. By carefully controlled methods, supplemented by introspections he was able to obtain far more accurate data from his subjects than had hitherto been obtained from other subjects with the questionnaire method. In order to make a complete survey of his subjects' associations he employed tuning forks, the simpler musical instruments and the pipe organ. One subject had colored odors and tastes and cutaneous audition all of which were studied as far as possible with the help of standard laboratory apparatus. The sound images or phonisms which accompanied pain, pressure and temperature sensations are without parallel in the literature. The other subject endowed letters and digits with human traits without the use of visual imagery. Whipple found that fatigue hindered the appearance of the colors, a find which was contrary to Flournoy's belief. Also, contrary to Bleuler's generalizations, Whipple found that the uniformities which were supposed to exist in associating light colors with high tones and dark colors with low tones were subject to serious question. His own observations, however, on only two subjects did not enable him to throw any light upon the origin of synaesthesia. In 1901 Laignel-Lavistine (74) found cases of synaesthesia in ten out of eleven individuals in a certain family of three generations.

In 1903 Urbantschitsch (137) investigated the synaesthesis of a limited number of subjects and here he compared the relative strengths of the associations between colors and tones when each ear was stimulated separately. He found the striking result that such bonds of association between colors and tones varied in strength with the stimulation of different ears in the same subject. He further made an attempt to find if the colors of tonal combinations followed the laws of color mixture. He sounded together two tuning forks, or two single tones whose colors were complementary on the one hand or antagonistic on the other. In a few isolated instances complementary colors, under these conditions, seemed to blend or to neutralize one another. The usual result, however, was the dominance of the color of only one of the tones. In the same year Dresslar (36) published a detailed study of an individual whom he tested in 1895 and again in 1903. He obtained the usual result, namely, that in the meantime practically no changes had occurred in the color associations. He also found, in agreement with other investigators, that the colors of words or of numerals were determined in several ways: (1) by the colors of initial letters; (2) by the colors of an accented syllable; (3) by the color of a repeated letter or digit; (4) by a digit or letter whose color was unusually vivid or striking. He discovered, as did Whipple, that fatigue made the photisms less vivid and clear.

Several cases of synaesthesia seem to originate so abruptly in the early life of the subject as to appear to result from shock or from some highly emotional experience. Occasionally such forms of synaesthesis are so vivid and persistent as to resemble hallucinations. Lemaitre reported an instance of this sort in 1904 (82) in a young child whose color associations were so vivid as to occupy the focus of attention whenever they appeared in consciousness, even blinding him temporarily to the extent that he was unable to perceive visual stimuli of ordinary intensity or brightness. This partial blindness lasted as long as the photisms remained in consciousness. In the same paper, Lemaitre reported a case of colored hearing in a child strikingly similar to that of the mother. In 1905 Rossigneux (119) attempted to show how certain instances of colored hearing, in poetry, followed definite laws. These laws related to the poetic and sound value of consonants and vowels. His conclusions, however, were based on insufficient data. In the same year, Smith (122) reported cases of synaesthesia in a father and his five children.

In 1907 Pierce (111) reported a hitherto undescribed variety of synaesthesia, gustatory audition. The subject was slightly deaf and so anosmic as not to be able to detect the odor of burning coffee. Tastes were recognized not only by means of the elementary taste qualities themselves but by the "feel" of the texture and of the astringency of different foods. Words were associated with these taste and pressure complexes. The following are typical illustrations: Alfred—cornbread in milk; Arthur—small particles of delicate lamb; Emma—pie crust; marry—raisins; hope—celery; loud—boiled potatoes; story—stewed cranberries; who—thick, salty cream. Many of these tastes would appear when the words occurred in conversation or in a lecture to which the subject was listening. The manner in which these words were pronounced influenced the associated tastes thus indicating that the synaesthesia was acoustic in origin. "Light" for example when rapidly pronounced aroused the taste of the soft, juicy lobe of grapes, but if pronounced slowly this same word aroused the taste of chicken gravy. Words had different tastes when pronounced by different individuals. This seemed to indicate that the quality of the sound determined the taste imagery. Her taste associations were so many in number that all of them could not be recalled voluntarily but when the appropriate stimulus was pronounced to her the associated taste never failed to appear. These associations could not be reversed unless the connection between the two sense fields had been remembered and had just been recalled. In testing for the taste equivalents of different words it was the habit of the subject to pronounce the words herself in order to "reinforce the auditory excitation." When in doubt as to the quality of the taste she applied pressure to her cheeks with her fingers. Taste associations were revived most readily when the subject was in a state of natural hunger, a fact which seems to point to a physiological basis. If a lecture or a conversation to which she was listening happened to be just prior to a meal the taste imagery was exceedingly tantalizing. Nonsense syllables, which had been unthought of by the subject before the experiment began, served to evoke taste qualities the first time they were pronounced to her. "Sut" gave mutton fat; "yoz" gave the taste of the white of an egg beaten stiff; "hes" aroused the taste of small particles of mince meat. Undoubtedly association played a considerable role in these latter tests. "Sut" might suggest "suet," a form of fat; "yoz" might suggest the sound of beating up an egg; "hes" sounds something like "hash" etc. Many of the subject's taste images were aroused in the absence of any awareness of the stimulus. For example at one time she was working in a library and while busily engaged in her work she suddenly tasted roast beef. Casting about for a cause, she heard men's voices in an adjacent alcove. The following facts seem to support the conclusion that this case depended upon physiological factors: (1) the associations were constant; (2) the subject was slightly deaf and slightly anosmic; (3) the taste qualities depended upon the rapidity and the quality of the auditory stimuli; (4) many of the taste qualities resisted introspective analysis; (5) the gustatory imagery was clearly localized in the reagent's mouth and was so vivid as to approximate actual taste sensations. In 1911, 1912 and 1913 the author of this study reviewed the current literature on synaesthesia (112).

Colored hearing in a color-blind subject was reported by Evans in 1907 (39). The subject was color blind to about an eighty per cent saturation of reds and greens. The right eye was myopic and the left eye was hypermytropic. Both eyes were astigmatic at asymetric axes. After twenty years of these eye defects the subject's sight was corrected to 36-20. Before this correction and notwithstanding these defects, various letters of the alphabet were colored. In such instances as involved red and green the subject either confused the two colors or identified them by their blue or yellow components. The author advanced the unusual view that colored hearing depended upon an insufficient balance of association or upon excessive powers of association along certain lines. Here the excessive associations were to be found between colors and sounds. These extreme associative tendencies were in turn dependent upon the fact that both the visual and the auditory excitations were linked up with the same tendencies toward motor expression. The motor expressions were made permanent by becoming associated with emotional processes. Back of it all as a condition under which these emotional processes arose, together with their motor accompaniments was a disturbance of the bilateral functioning of bodily physiological activities. Astigmatism, auditory defects, color blindness, speech defects and colored hearing were all dependent upon the proper balance or "cross-relation" in the bilateral functioning of the senses. A lack of balance conditioned these defects. When these forces, whose localization of function was bilateral were segregated or separated some unusual trait developed as a consequence. The tendency to form unusual associations was one of these consequences. In other words, colored hearing was the direct result of a lack of balance between the potential energy of the auditory and visual sense fields. The linking of auditory and visual excitations with a common but complex motor expression was also dependent upon this same lack of balance. Thus both stimulus and response were effected in like manner by the same cause. In summing up his theory, the author indicated that colored hearing represented an attempt on the part of the organism to adjust itself or to create a balance between segregated forces when such a balance was disturbed.

In 1907 Urbantschitsch (138) made another investigation of synaesthesia in which he found that the colors of sounds could be modified voluntarily by the subject and that external factors could also be made to modify the colors. In 1908 (139) the same author found that given a certain tone and its color equivalent, certain objective visual stimuli might be made to suppress the original association. This result could be obtained, however, only after the objective color was repeatedly presented to the subject at the same time as appeared the color equivalent of the sound.

In a similar fashion he was able to increase the strength of association between a color and a sound. In the same year Harris (56) described further instances of colored hearing in prose and poetry, the result of synaesthetic tendencies of the writers. This investigator criticised the current theories of colored hearing based upon the Hering and Helmholtz theories of vision. In these latter views it was held that the colors of tones followed the laws set forth in these theories of vision, i. e., if two tones aroused complementary colors, when the tones were given simultaneously, the result should be a grey. The author could find no evidence of this fusion in his own case.

In 1908 Laures (77) described a complicated form of synaesthesis in which "a" was associated with: (1) the color, green; (2) an insipid and unpleasant taste; (3) a sensation of coldness; (4) a tactual experience of touching a smooth surface like a pane of glass.

In 1909 Raines (114) found another peculiar form of synaesthesis. The subject had persistent color associations with tones, and certain drawings or figures such as a circle, triangle and swastika sign. Serrated lines were sea-green; the word "morning" was green; the symbol P.M. was red; evening was dark purple. The emotion of anger changed every red color equivalent to green. Odors, names of persons and names of many objects were likewise colored. Aside from these photisms, the subject possessed two complicated series of vivid imagery which tended to take possession of her consciousness whenever her mind was otherwise unoccupied. One of these sets consisted of vivid visual imagery of a green hill; the hill was surmounted by two broken marble columns; in the foreground of the picture was a blue sea. The second set consisted of a moorish gateway which led into a courtyard where the spray from a dashing fountain cooled the air. The atmosphere was perfumed with the fragrant odor of pomegranate flowers. Standing guard over this latter scene was a black giant clothed in garments of snowy white. This imagery could not be traced to any specific cause. It was present as far back as she could remember and had always been a source of great pleasure to the subject. This peculiar mental trait is consistent with the fact that the subject was a mystic and a spiritualist. She had premonitory dreams; she had acted once or twice as a medium and she had performed feats in automatic writing. One would be led to suspect that her persistent imagery was, perhaps, a hyterical phenomenon.

In 1909 Rose (118) published the results of a brief statistical study among two hundred fifty-four subjects all of whom were women. She found that nine per cent of them had color associations. In the same year Martin (92) attempted to discover if synaesthesis facilitated one's appreciation of art. Her method consisted chiefly in presenting copies of paintings to her subjects and her data was received from prospective and critical reports. The author claimed to have found certain instances of ''aesthetic synaesthesia.''

In 1907 and in 1910 Ferrari (43) reported several cases of synaesthesia. One of his subjects revealed such idiosyncrasies of taste and smell as a preference of bitter for sweet and a fondness for disagreeable odors; and in this same subject tastes and odors were colored. In 1910 Mercanté (97) published a summary of an investigation among children and adolescents. He found eighty per cent of young girls to possess some form of synaesthesia but a somewhat lesser number among the boys. He concluded that synaesthesia was not only normal but the usual thing in children between the ages of eight and eighteen. Since there was a striking uniformity in those colors which were associated with vowels the author suggested that there might be a certain affective response to vowels and a similar affective response to the colors, that would explain this situation. Also in 1910 Lemaitre (83) published a statistical study of synaesthesis among adolescents. He found that only twenty-five per cent of his subjects had secondary sensations, half of which number, he believed, would lose their photisms after reaching maturity. It is interesting to note that Lemaitre found ''i'' to be associated frequently with white and ''o'' with black, a condition quite the contrary of the results found by Calkins and Jordan. Although Lemaitre was dealing with the French language and the latter investigators were dealing with the English language, ''i'' and ''o'' look quite the same in either language. This would indicate that their method of explaining these associations was faulty.

In 1913 Coriat (29) found colored pain in an abnormal subject who was afflicted with many ailments, hysterical hemerania, neurasthenia, somnambulism, transitory paralysis of the legs and right hemihyposthesia. Her field of vision was normal for form and for color. Hollow pain was blue; sore pains were red; headaches were vivid scarlet; and shooting neuralgia pains were white. The colors were exceedingly vivid and persistent when the pains were severe and prolonged. As the pains increased in their intensity the corresponding colors increased in brightness. This condition the author attributed to a process of summation. When the patient became hyperaesthetic on one side, a Von Frey hair aesthesiometer produced long-enduring pain after-images which latter were always highly colored. Both the pain and the color varied inversely as the length of the hair. Binet reported a similar case (12) in which tactual stimulations secretly administered by a needle prick failed to arouse a sensation of pain but gave rise to brilliant flashes of light. The patient was henianaesthetic and the stimulations were applied in the insensitive regions. In another patient and under the same conditions, Binet found that the tactual stimulations aroused black or very dark colors instead of brilliant flashes of light.

In 1911 Medeiros and Albuquerque (93) supported the association view of the origin of synaesthesis. They contended that secondary sensations were much more common than most investigations indicated, and that the peculiar use of certain letters in different languages might lead to the formation of color equivalents. The idea was suggested to them by the fact that in the Portuguese language ''u'' is associated with black. Here ''u'' is the accented vowel in many words which signify black or dark objects. The usual difficulty of applying such a rule to all instances of synaesthesia is encountered here as well as in all other attempts to explain synaesthesis on the basis of association. In the same year, Ziehen (145) suggested that certain varieties of synaesthesia might be explained by the principle of irradiation in the same way as is explained the pains which shoot over the face when one is suffering with the toothache. On the other hand certain other varieties of synaesthesia could be explained only by having recourse to principles of association.

In the same year also, Downy (33, 34) reported a case of colored gustation in a subject who had defective taste. The color associations were very vivid and persistent, lasting at times as long as ten minutes after the tongue had been stimulated. The colors were unusually vivid when the subject was ill. Here, as in Pierce's subject, taste qualities were intimately fused with pressure qualities and the latter often determined the associated color. The subject salted or sweetened her food in order to change the ''feel'' and not the quality of the taste sensation itself. Many of this subject's associations could be traced to the act of connecting the colors of objects with their tastes for often the photism corresponded exactly with the natural color of the food. The subject's limen for bitter sensations was abnormally high but for the other three taste qualities the limens were nearly normal. When weak or indistinct taste qualities were confused the colors were correspondingly fleeting and vague. The colors of tastes could be intensified by stimulating the subject with smells simultaneously with tastes. The more intense was the stimulation of the tongue, or the greater the area covered on the tongue, the more brilliant and lasting were the photisms. Odors failed to modify the quality of the taste-colors but rendered them more easily stimulated when weak solutions were applied to the tongue. As a rule sweet tastes were black; bitter tastes were red; salty tastes were some form of grey and sour tastes were varied shades and tints of green. If the liquid stimulus was cooled it had the result either of making the photism more brilliant or of arousing the complement of the photims. If the stimulus evoked an indistinct color, the color was made more distinct by adding salt to the solution. Sour solutions modified the color of bitter stimuli and neutralized the color of sweet stimuli. At times bitter and sweet stimuli, applied simultaneously, neutralized the colors. After-images from visual stimuli did not influence the colors of the tastes in any way. Certain tactual sensations, alone, gave photisms but in none of these latter instances were the colors so vivid as for tastes. Downey (35) made a study of the alleged literary value of synaesthetic expressions in poetry. Thirty-four fragments of verse from Poe, Shelly, Keats and Blake were presented to six observers with the instructions to select from the total number fifty short passages which seemed to possess the most literary value and to arrange these passages in order of their affectiveness. The verses involved descriptions of light in terms of sound, sound in terms of light as well as ordinary passages of description. Downey concluded, (1) that there could be detected in poetry no certain indication that the authors had synaesthesia; (2) that if a poet, with synaesthetic tendencies, made use of synaesthetic descriptions, his poetry would be incomprehensible to the general reader; (3) that the thirty-four fragments of verse which were selected for the experiment might have represented poetic ideosyncrasies on the part of the authors rather than synaesthetic tendencies.

In 1912 Marinesco (91) described the synaesthesis of a Roumanian woman who had an endless number of color equivalents for various sounds, including spoken words, and for written words. In this paper were included several colored plates representing the subject's photisms. Colored letters sometimes appeared on backgrounds of a slightly different hue or brightness, and the backgrounds varied irregularly in size and outline. Sometimes the backgrounds tended to assume the general form of the letter. In this paper, also, is to be found a rare bibliography.

In 1913 Bleuler (15) devoted an article to a criticism of the association theory, a paper which was evidently inspired by a particular desire on the author's part to refute the arguments of Pfister (108) who had written in favor of the association view the year before. Bleuler accepted a physiological theory for the following reasons: (1) dark or dull colors are associated with low tones, bright colors are associated with high tones; (2) the size and shape of the colors vary in the same direction as the pitch of the tones; (3) consonants are generally paler than vowels; (4) variations in the primary sensation uniformly produce variations in the secondary sensations; (5) colors are associated with other sensations so early in childhood as to precede the development of meaning or recognition. For instance a color may be associated with a certain letter or sound before the child knows the meaning of the stimulus or before he is able to recognize it and call it by name. Associations, alone, would reveal no such uniformities as have just been mentioned. Moreover, the colors of sounds are not "optical," not visual perceptions or ideas, for they possess qualities which are different from either visual sensations or visual ideas. Among these differences are their localizations in time and their subjective and objective reference. In other words photisms of colored hearing are not "seen" but are "heard;" the photisms of tactual sensations are not "seen" but are "felt."

In 1913 Wehofer (143) presented the general subject of synaesthesis with a description of his own and other cases. He reviewed the arguments for and against the association and physiological theories and offered the suggestion that the efforts of investigators be directed toward correlating the facts of colored hearing with the facts and theories of audition rather than with the facts and theories of vision. The writer himself was a musician and a student of Berlioz. He often attended recitals and musical festivals with a friend who likewise had colored hearing. Together they studied the behavior of their photisms while they listened to the music. Wehofer found that in his own case affective processes greatly influenced the quality of the photisms and the readiness with which the colors were evoked.

In 1913 Coriat (30) described a case of synaesthesia in a hysterical patient. Colors were associated with sounds and with words; the days of the week had different "heights;" the seasons of the year had different "shapes" or "forms;" tastes were colored and affective processes were also colored. In this subject the color associations were irreversable, a fact which the author believed pointed to a physiological theory. An attempt was made to discover the origin of the synaesthesis by means of the free association method and hypnotism, but in this attempt only negative results were obtained. The absence of after-images when the subject held the photisms in consciousness for relatively long periods of time indicated that the synaesthesis was purely cortical. Coriat resorted to Sherrington's view of irradiation and suggested that there might be in the cortical projection fields an irradiation of specific sense energy into adjacent projection fields. There might also be an incomplete differentiation of function in these adjacent fields so that an excitation which reached one area, say the auditory, would arouse a molecular disturbance in an adjacent area, say the visual. In this way visual secondary sensations would result. This condition in the cortex might be congenital which would explain the early origin of synaesthesis in the life of the individual.

In 1901 and again in 1914 Lemaitre (81, 84) described some very remarkable cases of personification. He found that about three per cent of adolescents between the ages of twelve and fifteen showed a tendency to endow letters, numerals, or certain words with human traits. One subject experienced considerable difficulty in solving arithmetical problems because of the fact that the digits with which he was working gave rise to vivid and persistent dramatizations. The numeral 8 was a husband whose wife was 4; 3 was a son, twelve years of age; 6 was a timid and feeble daughter; 9 was a wealthy individual, a good friend of 8 but a special friend of 4; 7 was a woman of high social rank and a friend of 8; 5 was a charming lad, very unpretending, who held a unique relationship with each of the members of the family; 1 and 2 were insignificant individuals. The wife, 4, disdained her husbands affections and sought the friendship of 9. Whenever the subject attempted to solve a problem in arithmetic there appeared these personified numerals in human form and outline, standing in a row in the order named above, and in the center of an immense circle. The circular plot of ground was surrounded by a grassy plain. Out on the plain was the habitual residence of the wife, 4, who never left her house except to go in search for her son, 3. At one side of the circle was a steep incline which lead upward in one direction to a stone embankment and downward in the opposite direction to a deep crevass. Then there appeared 4, with her son 3, near this wall. When they approached the wall the numerals combined to make 12. 5 and 3 then appeared on top of the embankment; they were seen to shake hands, whereupon the numbers combined to make 15. At the moment when the numbers combined, the human forms disappeared. Beyond the wall on a level terrace above was situated a stone enclosure where dwelt the numeral 5. After 5 had combined to make three, it reappeared and went into this stone enclosure. 7 then appeared on the brink of the precipice where 3 was seen to join him. 3 and 7 then combined to make 21. 4 was next seen chasing 7 in the direction of the chasm and when both numerals arrived at the chasm's edge they combined to make 28. In this fashion another drama was staged by 5, 6, 7, 8 and 9, in which, from time to time, different pairs of these numerals combined to make larger figures. Lemaitre thought that the subject formed the habit of dramatizing these numerals when he was very young and in the first stages of learning writing, language and vocabularies.

In 1914 Langfeld (75) described a case of synaesthesia which, like many others tended to point to a physiological theory. Here the colored hearing seemed to follow the laws of color mixture in that when two tones whose colors were .complementary were sounded simultaneously there appeared an approximate grey. This result was best obtained when the original colors were blue and yellow. Musical chords assumed the color of the fundamental. The subject could see the color of a tone when the name of the tone was mentioned as well as when the tone itself was presented to her. In the sames year Myers (100) reported a form of colored hearing where the colors were determined conjointly by the intensity of the tone and by the pitch. This author believed that the color associations were neither sensory nor imaginal, but imageless and verbal. He suggested that the associations were formed in childhood when primary perceptions were still vague and undifferentiated. Synaesthesis was the persistence of this vague and undifferentiated form of perception. Aside from this the subject probably showed a strong tendency to form synaesthetic associations between those sense fields in which there remained vestiges of the old, imperfect and undifferentiated sensory experiences. This view was attacked by Langfeld, Pierce and others. One of Myers' subjects was the Russian composer, Alexander Scriabine. The composer once tried to have his ''Prometheus and Mystery'' given with colored lights and odors in order that the visual, auditory, and olfactory sensations might blend into one great harmony and thus produce a greater effect upon the audience. Scriabine's colors were associated with the harmony of music and with musical tonality. Changes in the colors often preceded the change in tonality with which the colors were associated. This made it possible for the composer to judge harmonies by their colors. In 1916 (14) Blanchard seemed to have found a successful method of producing a sound-color harmony at a musical performance.

In 1917 (71) Jordan reported on the photisms of his son, on whom tests had been made between an interval of five years. Several minor changes had occurred in the color associations, all of which were evidently due, however, to inaccuracies in describing the colors.

In 1918 Alford (2) reported two cases of colored hearing in two male twins, twenty-seven years of age. Both subjects were very much alike in their mental traits. Both were brilliant students in all their studies; both could perform remarkable feats of learning; they liked and disliked the same things; both were fond of poetry, art, and architecture and both were temperamentally emotional, sympathetic, sensitive, shy and modest. On one of the subjects tests of the photisms were made three months apart. Unfortunately the experiment had to be abandoned very early in its course for the reason that the subjects became suspicious and failed to cooperate. 150 proper names were used as stimulus words and in a rather loose manner the subjects were asked to write the names of the colors which the stimulus words aroused. In certain instances the names evoked no color at all; in other instances they evoked several colors among which the dominating color was hard to determine. In most instances the colors were practically as vivid as the real sensations. It was found in this investigation, contrary to Whipple's results, that under conditions of fatigue the colors were more readily stimulated. After the subject sat in an experiment for longer than half an hour there appeared a persisting and confused array of colors which always obscured the appropriate response. A possible indication of reversability of the associations was found in one of the subjects who could recall several proper names when the stimulus word was a certain color. The responses were the names which always aroused that particular color. Although the colors remained fairly constant over a period of three months, certain stimulus words aroused a color during the first tests and failed to arouse any color in the second test. Conversely certain words which failed to arouse colors in the first test did so in the second. One of the purposes of this investigation was to discover how nearly the associations of the two brothers resembled one another. It was found that the photisms were similar with 67 per cent of the test words. Harris and his brother had previously reported a similarity in their own cases of only 50 per cent (56). As the author suggested, the 67 per cent was probably too high and had the method been more refined and the descriptions of the colors more accurate, the similarities would have been less noticeable. Alford suggested that spectra and scotomata might be synaesthetic phenomena. Several indications in this study point to the associative origin of the synaesthesia: (1) the associations were frequently reversable; (2) certain words evoked colors at one time and not at another; (3) the name Brown was ''brown.'' Sue was blue, Fern and Verne were green, Monday was blue (blue Monday) and the like.

SUMMARY OF HISTORICAL REVIEW .

No thorough going study has been made of synaesthesis in the blind. Only seven of such cases have been described in the literature which the present writer has been able to obtain. There have appeared no characteristic differences between synaesthesia in the blind and in the seeing. The relationship of synaesthesis in the blind to the onset of blindness if there is any such relationship, has never been worked out. The only theory which has been offered to explain synaesthesis in the blind was offered by Phillipe (109) who thought that such associations were due to an effort on the part of the subject to retain his memory for colors. If Phillipe's results are to be accepted as representative, synaesthesis would seem to be slightly more prevalent among the blind than among the seeing, suggesting that a certain number of such cases may follow from the fact that the subjects have lost their sight. In those cases of synaesthesis which have developed before the subject became blind no subsequent changes due to blindness have been noticed.

Frequency of Synaesthesis: The frequency of synaesthesis among adults has been found, under varying conditions of age and sex, to range from nine per cent to fifteen per cent. The frequency among adolescents has been found as high as twenty-five per cent. It seems probable then, that many cases of synaesthesis disappear when the subject reaches maturity.

The following is a list of the different varieties of synaesthesis which have been reported in the literature. They are arranged according to the apparent stimulus. It happens that the list indicates in a general way the order of their frequency, beginning with the first as the most common variety.

I. Of acoustic origin
  A. colored hearing
    1. isolated tones
    2. noises
    3. music
    4. chords
    5. vowels
    6. consonants
    7. words
      a. names of people and other proper names
      b. common parts of speech
      c. days of the week
      d. months of the year
      e. seasons
      f. epochs of history
      g. virtues and other abstract terms
      h. phases of human life
      i. names of tastes
      j. names of odors
    8. digits
    9. dates
  B. gustatory audition
    1. taste equivalents for words
  C. figured audition
    1. geometrical forms associated with words
  D. pain-audition
    1. toothache equivalents for tones of certain quality

- II. Of visual origin
    - A. colored lines
        - 1. serrated lines
        - 2. broken lines
    - B. Colored forms and figures
        - 1. geometrical forms, square, circle, rectangle, triangle etc.
        - 2. colored angles, obtuse, acute
        - 3. colored signs and designs, swastika etc.
        - 4. colored multiplication, division, addition, subtraction signs
    - C. colored letters, digits, words etc.
- III. Of gustatory origin
    - A. colored tastes
    - B. colored taste and pressure complexes
    - C. colored taste and odor complexes
- IV. Of olfactory origin
    - A. colored odors
- V. Of tactual origin
    - A. colored pain
    - B. colored pressure
    - C. colored temperature sensations
        - 1. warm
        - 2. cold
        - 3. mixtures
    - D. auditory pain
    - E. auditory temperature sensations
    - F. cutaneous or muscular taste (see page 5).
- VI. Of affective origin
    - A. colored pleasantness and unpleasantness
    - B. colored emotional complexes
- VII. Of possible combined visual and auditory origin
    - A. personification and dramatization of letters, digits, days of the week. (It is more likely, however, that associations play a very important role in the origin of this form of synaesthesis.)

Localization of secondary sensations in synaesthesis. Colors for sounds are usually localized in the direction of the sound but in a few instances such colors have been localized on the brain or against the forehead. The color equivalents for letters, digits and words are frequently localized in space in front of the individual, or as backgrounds upon which the letters or words are visualized. In a few instances of this latter sort, the letters themselves are colored. The photisms of taste have usually been localized in space in front of the subject. Taste equivalents for sound have always been localized in the mouth of the subject. In brief, the secondary sensations have been localized almost invariably as if they were the primary sensation no matter to what actual primary sensation they have been attached. This would indicate that in most forms of synaesthesia the secondary sensations depend upon a sufficient differentiation of function in the sensory centers to warrant a consideration of the laws of that sense field from which the secondary sensations are derived.

Methods of attack upon the problem. (1) By means of standard laboratory apparatus efforts have been made to survey, exhaustively, the varieties of colored hearing in different individuals in view of discovering the extent of the phenomenon, its constancy and the factors which influence its intensity, quality, duration and clearness. (2) Attempts have been made to add to our knowledge of the problem by the use of hypnotism, the free association method and by resorting to recall of the subject's earliest memories. (3) Investigators have tried to find the appropriate stimulus for the secondary sensations by resorting to modifications in stimuli, to the use of distractions or counter stimuli or by reversing the order of the association, if possible. (4) Another method has consisted of the application of weak farradic currents to different portions of the cortex. (5) Attempts have been made to correlate synaesthesis of different forms with ideational types and with temperamental or emotional types. (6) The reaction method has been used in order to find the association time between colors and their associates. (7) Statistics from questionnaire methods have been used in order to discover uniformities of various sorts among different individuals having synaesthesis. (8) Attempts have been made to ascertain the modifiability of secondary sensations under voluntary effort and practice or in the presence of continued distractions. (9) Data have been collected from large numbers of individual cases in view of explaining the origin of synaesthesis, the manner in which it develops and the degree of persistence of the phenomenon. (10) Attempts have been made to correlate the functioning of visual secondary sensations with the laws of color mixture and the functioning of olfactory and gustatory secondary sensations with the laws of smell and taste.

Generalizations from experimental data. Experimental evidence warrants only a few generalizations concerning synaethesis. Uniformities which seem to possess the least number of exceptions are: first, synaesthesis may be permanent as far as tests show; secondly, in colored hearing, tones of high pitch are associated with bright or light colors and tones of low pitch are associated with dull or dark colors; thirdly, an increase in the intensity of the primary sensation is accompanied by a corresponding increase in the intensity or brightness of the secondary sensation; fourthly, synaesthetic associations are not, as a rule, reversible; fifthly, the areas in the brain involved in synaesthesis are adjacent to one another; sixthly, synaesthesis begins in early childhood. The following negative conclusions are perhaps the most striking in the literature: (1) there is no uniformity, among different individuals, in the hues which are associated with tones of like quality or pitch; in the colors which are associated with the same vowels, letters, words, consonants and diphthongs or with the same tastes, odors, pressures, etc. (2) Various experimental methods have failed to throw light upon the problem of ultimate nature of synaesthesis or upon its origin. Among these are the reaction method, hypnotism, the free association method, weak farradic stimulation of the brain, correlating the associated colors with the laws of color mixture, observing the effects of distracting or counter stimuli, and attempts to voluntarily inhibit the secondary sensations. On the other hand, the debatable problems are: (1) synaethesis is either inherited or it is not inherited; (2) fatigue diminishes the intensity or brightness of the secondary sensations or has the reverse effect; (3) synaesthesis may best be explained on physiological grounds or it may best be explained by means of the principles of association.

Factors Determining the Nature and Attributes of the Secondary Sensations. The hue of color equivalents for sound is generally determined by the quality of the tone. The brightness of the color is determined by the pitch and intensity of the sound. The hue, in other instances may be determined either by an emotional accompaniment of the sound sensation or by fortuitous associations. The color equivalents for chords are determined either by a component tone whose color is striking, by the fundamental tone, or by mixing the colors of the component tones. Colors for music are determined either by the key in which the music is written or by the composer's name. The colors for vowels may be determined by the shape of the letter, by the sound of its pronunciation, by affective concomitants, or by peculiar methods of usage of the vowel. The colors for consonants may be determined by the same factors as in the case of vowels, or by the position of the consonant in certain words. Color equivalents for words are determined by the color of accented vowels or consonants, by the colors of letters which are repeated in the word, by the colors of initial letters, by a mixture of the colors of component letters, by affective accompaniments, by the color of a component letter the hue of which is unusually striking, by associating the word with the natural color of the object for which the word stands etc. The colors for tastes and smells are often determined, apparently, by the natural color of the objects tasted and smelled. On the other hand words for tastes may be colored according to the color of the odor which is commonly associated with such a taste. The colors for digits may depend upon the numerical value of the digit. The colors for dates or large figures may be determined by component digits, by the class of the numeral, or by the number of syllables in the name of the figure. Other conditions which may influence the quality or intensity of secondary sensations are fatigue, emotional experiences and mode of stimulation. Fatigue generally reduces the intensity, clearness and hue of the secondary sensation or lessens its liability of appearance; on the other hand, one investigator found it to have almost the opposite effect (see page 3). Emotional processes may intensify the secondary sensation or alter its quality, entirely. The mode of stimulation may increase its liability to appear, it may increase its clearness or intensity, or it may alter its quality. In the case of colored hearing differences have been noted in the photisms when each ear has been stimulated separately. The use of counter stimuli has been known to alter the nature of the photisms in colored hearing. In rare instances voluntary efforts to modify or to inhibit secondary sensations have evidently been successful. In rare instances, also, such factors as color-blindness, a condition of hyperaesthesia, and defects in the sense organs have been known to determine the nature and quality of the secondary sensations. More of such determinants of the attributes of secondary sensations might be cited but their lack of verification and uniformity among different individuals makes it hardly worth the while. In fact many of the factors just mentioned have been noted only in isolated cases and it is perhaps questionable whether the reports are always accurate.

Theories of the Origin of Synaesthesis. Four different classes of theories have been advanced from time to time in the literature: the pathological, physiological, association or psychological and a combined physiological and psychological theory. The early attempts of Cornaz (31) and Marcé (89) to attribute colored hearing to an eye defect have been discredited. We have, therefore, the three remaining views. The first noteworthy physiological interpretation was advanced by Nuel (102) and since that time there have been made many supplementations, suggestions of omissions or corrections by different writers. The theory in general includes the important fact that functionally, and perhaps anatomically, there is a close relation between those reflex arcs and brain areas which give rise to the primary and secondary sensations. The functional relation may be one of irradiation, of interaction, of reciprocal innervation, or of a lack of differentiation of function. It may be that the anatomical relationship is one of anastomosis of afferent fibers or of adjacent areas in the brain. In the light of recent theories of irradiation and summation in reflex arcs, the anatomical condition of anastomosis or of tangling of fibers seems to have lost its importance. At any rate such discoveries have had the result of producing a change in the emphasis from structural to functional factors in a theory of synaesthesis. The most plausible explanations, perhaps, rely upon an irradiation of impulses from their usual center to adjacent centers of the brain. In the projection areas of the latter there is thought to be such a lack of differentiation of function as would give rise to secondary sensations. This lack of functional differentiation might account for the simultaneity in the appearance of the secondary sensation with the primary sensation. It would also account for the dependence of the former upon the latter in intensity, clearness, quality and duration. As Epstein suggested, afferent impulses may be deterred into other channels at the corpora quadrigemina or in other basal ganglia. There may be in the appropriate areas of the brain a certain blood distribution, resulting from shock, emotional experiences or some unknown physiological cause. This distribution might affect the functioning of the areas concerned and no others. In this way energy in the form of heat might be so distributed between these two areas as to stimulate them into simultaneous functioning, thus facilitating irradiation or increasing the results of a lack in differentiation of function. The unique view advanced by Evans (see page 22), although seemingly impossible in its present form, may be modified, eventually to the advantage of a general physiological theory. It takes into account certain physiological principles which other theories omit and which may prove to be highly important, for example, the balance in bilateral functioning of the body and the linking up of synaesthesis not only with conditions of stimulation but also with conditions of response or motor expression. It seems plausible that synaesthesis may depend quite as well upon the functioning of entire reflex arcs as well as upon functions localized specifically in the brain centers. Some forms of synaesthesia may have an origin similar to that of the conditioned reflex.

The following facts support a physiological view: (1) the almost simultaneous presence of secondary with primary sensations at the point of origin; (2) the close proximity of brain areas involved in synaesthesis; (3) the stimulating influence of drugs; (4) the irreversibility of synaesthesis; (5) the destructive influence of fatigue or the reverse effect; (6) the disappearance of synaesthesis in adolescence or in senescence; (7) the dependence of attributes of secondary sensations upon the properties of the stimulus of the primary sensation; (8) the appearance of synaesthesis in early childhood at a time when meaningful associations are not yet formed; (9) the spontaneity and suddenness with which synaesthesis begins.

The first important psychological explanation of synaesthesis was given by Perroud (107). In general this type of theory may rely upon the alleged fortuitous and simultaneous experiencing of sensations from two different sense fields or upon the habit of constantly visualizing objects in their natural colors. Again, an experience in one sense field may become associated with an experience in another sense field for the reason that both experiences have a common affective concomitant. It may be, also, that colors are deliberately associated with tones, letters and the like, in certain instances, in order that the subject's memory may be improved. In the main, each individual case of synaesthesis must be interpreted differently, if one is to rely upon an association theory. The details of individual cases differ widely as well as the conditions under which each case originates. There are undoubtedly certain forms of synaesthesis which are the outcome of associations. The weakness of an association theory, however, in accounting for the general phenomenon is its inadequacy in covering a majority of all cases, even of the same type. Moreover, the association view, in a last analysis, must rely upon a physiological explanation. The few instances in which the association view seems adequate are: (1) cases which date from some unusual event or experience; (2) photisms which correspond to the colors of the object originally sensed; (3) photisms whose colors are suggested by the position of a letter in a word which designates a certain colored object.

It is clear that such differences of opinion as have existed from time to time between investigators of this problem have been the result first, of generalizations from too few cases; secondly, they have been the result of the vast differences exhibited between different varieties of synaesthesia, and of the great complexity of the phenomenon and thirdly to the fact that both physiological and association views have seemed adequate to meet the demands of individual cases while neither view has apparently met the demands of all cases. In such cases as colored odors and tastes, in which the photisms correspond to the natural colors of the objects tasted or smelled, for example, it would be the natural thing on first thought to resort to an association theory, but after all, a physiological view would probably in these instances provide a better explanation than to rely upon the traditional process of association for association is not a cause, as the writer sees it, but a physiological condition. Furthermore, to be understood, association must be described in such terms as irradiation or draining of physiological processes. In a last analysis, therefore, the final appeal must be made to a physiological theory.

THE SYNAESTHESIS OF A BLIND SUBJECT

The subject whose synaesthesis is described in this section of the paper is Thomas D. Cutsforth, a graduate of the University of Oregon. He lost his sight by accident at the age of eleven and at the present writing he is twenty-seven years of age. He has had an extensive laboratory training in psychology and is a good introspector. His general scholarship was exceptional and his work in psychology was uniformly excellent. He is at present engaged in teaching, and in the near future he plans to continue his studies in psychology by taking graduate work.

The following is a list of his various forms of synaesthesia and allied phenomena:

1. colored tones; colored auditory imagery of these tones and photisms for the names of these tones
2. colored music; colored auditory imagery of music; photisms for names pertaining to music
3. colored vowels and consonants, covering the entire alphabet
4. colored voices; similar colors for the name of the person whose voice is colored; similar colors for visual imagery of these persons and for verbal imagery of the persons' names
5. colored proper names, cities, towns, states, countries, places etc
6. colored cutaneous experiences; photisms of kinaesthetic experiences, touch and kinaesthetic blends
7. colors for abstract terms, theories, beliefs
8. colored tastes and odors; photisms for the names of tastes and odors, which often correspond with the colors for the tastes and odors themselves; colors for auditory or verbal imagery of these names
9. colors for names of the days of the week, months of the year

10. colored digits, dates, telephone numbers etc., and for auditory and verbal imagery of the same
11. colors for the directions—south, north, east and west; similar colors for auditory and verbal imagery of the words
12. colors for affective experiences and certain emotional complexes
13. photisms in dreams, associated with imagery in other modalities and with visual imagery itself
14. colored number forms, week, month, century and alphabet forms

A series of experiments was made during the winter of 1916-17 and in the summer of 1919 in view of determining the constancy of these colored associations. The tests were made on February 9, March 9, June 9, 1917, and on August 15, 1919. Preliminary tests revealed the following facts which enabled us to simplify the method:

1. The subject experienced some difficulty in properly labeling the different colors. Therefore we resorted to the method of asking him to select certain known objects whose natural colors, as he remembered them, resembled the color of the photism he was attempting to describe. Accordingly, many of the colors are described in the text as as a beeswax yellow, the yellow of newly sawed boards, fawn color, cherry red etc. Some allowance must be made, therefore, for slight variations in terminology, in comparing the photisms for the same stimulus over long periods of time. In repeated tests, however, the subject was able to choose his comparisons with remarkable accuracy.

2. It was found that the colors for imagery of tones, voices, tastes etc. were identical with the colors for the actual primary sensations themselves. The subject was able in this way to arouse the color of a certain tone by getting an auditory image of the tone and the same way with taste. Moreover, in most instances the same colors were aroused when the experimenter named a person as were aroused when the subject heard that person speak. Certain of the tests were given, therefore, with the names of tones, persons, tastes and the like as stimulus words. The accuracy of the results was checked in two ways, by resorting from time to time to the primary sensation as the stimulus and by resorting to complete introspections from the time the stimulus word was given to the time the appropriate color appeared. In cases of unfamiliar tones or objects, as for example certain touch blends and organ tones, actual objective stimuli were employed.

3. The subject has a habit of translating the voices of other people into verbal imagery of his own voice. This peculiar ten-

dency appears very conspicuously in his dreams where conversations between persons in the dream appear in the reagent's own voice. This imagery is accompanied by the colors appropriate to the person's voice in question, and is identified by color instead of by quality of voice. By resorting to verbal imagery as a stimulus, as well as the name of the person and the person's voice itself, it was very often possible to check the accuracy of the results.

Colors appear for voices of all persons whom the subject has heard speak, whether in conversation, or a lecture; singer's voices are also colored. These colors appear the first time the voice is heard and are projected in the direction of the sound. They appear as small clouds or ''fog-banks'', sometimes spoken of by the subject as ''blankets''. Usually the photisms are more vivid and persistent when the stimulus is the voice itself. After periods of several months or years during which time the reagent has not heard a particular voice, the colors begin to fade, usually turning into some shade or variety of brightness before disappearance altogether. On the other hand the colors are apt to remain longer than any memory of the person's name. As soon as the reagent becomes familiar with a person, auditory and verbal imagery of that person's voice readily excite the appropriate color. The brightness and the hue of such photisms oftentimes resemble one another to a marked degree, yet there is always some distinguishing feature about each photism which enables the subject to identify it easily. He is able to compare these relatively similar colors with striking readiness. For example the color of C's voice is very much like M's but lighter, or J's is like O's with the exception of a few black specks in it etc. It has been impossible to explain the reasons why particular hues or brightnesses become attached to particular voices except in rare instances where the photism seems to result from associations. For example Ha's voice is ''pink'' because the voice lacks character and ''pink'' is a faint and characterless color for the reagent. Occasionally the brightness of the voice is determined by the affective tone which accompanies the subject's perception of the voice. Congenial voices are apt to be bright or silvery grey. Disagreeable voices are often very dark or almost black. But there are many exceptions to these rules. A peculiar complication enters into the subject's photisms in connection with voices. Not only does the person's name arouse the color of the voice, but the name itself often possesses a color of its own, determined in part by the component letters. For example W's name arouses the silver grey photism of W's voice and also a relatively pure white photism which is associated with the name, alone, as a word.

The colors for persons occasionally undergo slight changes both in hue and brightness as time elapses from the last hearing of the person's voice or as the reagent's emotional attitude toward the person changes. The brightness of a photism sometimes becomes more marked as the relationship between the reagent and the person in question becomes more congenial. If the relationship changes from a pleasant to an unpleasant one the photism is apt to become darker. At the present writing introspective reports show that both like and dislike for a person produce a light halo or overcast about the photism and that the quality of the person's voice, analyzed more thoroughly as the reagent becomes acquainted with it, governs the coloring of the photism. One example illustrates the change which a photism undergoes under these conditions of familiarity and change in attitude. A certain person's voice was originally a very dark and richly saturated brown. On further acquaintance, dislike for him changed to congenial friendship and with this change the photism became brighter and developed a "shiny gloss such as observed on the surface of polished woodwork." The richness of the brown did not change perceptibly.

The following are typical examples of photisms for voices. The left-hand column contains the initials standing for the person whose voice is colored. The descriptions are taken verbatim from the reagent's introspections. On March 9, 1917, and June 9, 1917, the stimulus was either the person's voice or the name of the person given to the reagent shortly after hearing the person's voice. On August 15, 1919, the reagent reported his colors from auditory imagery of the person's voice or from associations aroused by the person's names. In considering this latter series of tests, it should be borne in mind that unless specified in the tables, the reagent had not heard the actual voice for several months and in certain instances not for two years:

	March 9, 1917	June 9, 1917	August 15, 1919
Wh.	silver grey	whitish silver on dark grey background	dark grey with bright silver gloss
Con.	greyish yellow, old straw-color	brownish yellow, color of a ripe English walnut	yellowish grey, poorly saturated, like old beeswax

	March 9, 1917	June 9, 1917	August 15, 1919
Sch.	dark bluish black, very muddy, black predominating	dark muddy color, slight greenish tinge	‘‘smudgy’’ grey, very dark; dusty overcast, tinged with yellowish brown; ‘‘negro’’ color
DeC.	reddish brown	reddish brown, slightly yellowish	a greyish red-brown, poorly saturated
Cam.	bright canary yellow	canary yellow	a very bright yellow, golden or canary
Hag.	chocolate brown, very dark	chocolate brown	dark, rich reddish brown, chocolate in appearance
Hay.	dark grey; light streaks running through it	light grey, darker at times, fluctuating in brightness	a rich dark silver grey
Reb.	dark reddish brown, also blue tinge	very dark brown; bluish tinge	dark mahogany; reddish brown; fringe of poorly saturated brown
Zah.	orange	orange, yellowish	a washed out orange bordering on a poorly saturated yellowish brown
Sha.	maroon	glossy red, maroon color	poorly saturated red; a sort of faded maroon

The following are voices which the reagent has heard repeatedly during the progress of the experiment:

Fat.	steel grey	shiny steel grey	dark dusty grey poorly saturated
Mot.	bluish grey, dove color	smoky grey, bluish tinge	mouse color, not very bright, faded appearance
Sis.	yellow; beeswax	mixture of yellow and pale orange, like new rope	well saturated yellow but rather dark
Bro.	the black of a faded umbrella	dark dusty brownish black	smudgy black, almost a faded dark grey

The following are colors for voices which the reagent has not heard for periods of three to five years; the photisms are associated with auditory imagery of their voices:

Tof.	black	greenish black, very dark	deep black
Ros.	brown, reddish tinge	brown	dark reddish brown
Cha.	bluish green with yellow overcast	greyish green, dusky	dark bottle-green
Wes.	a very light dove-grey	dove grey	silver grey with slight tinge of yellow
Hor.	bright yellow	yellow	very light yellow, bordering on light yellow-tan

High tones arouse small photisms of a faint hue and light tint, merging into light greys as they become higher. Low tones give large, dark photisms, with rarely much hue. Intermediate tones give photisms which are moderately bright and moderately saturated. The size and brightness of the photisms for tones vary also with the intensity of the sound. Loud tones produce colors of lighter tints but do not otherwise alter the hue. Combinations of tones result in a superposition of colors and very rarely in what could be called a mixture. There is never a true neutralization of complementary colors. If actual sounds are used as stimuli, the colors remain in consciousness as long as the reagent attends to the auditory perception. If an auditory image is the stimulus, the photism is unsteady and fluctuates in clearness between a maximum which undoubtedly corresponds closely to the clearness of a visual perception, to a minimum clearness, characteristic of a vague and fleeting visual image.

When several tones are sounded in a chord, or when the reagent is listening to music, colors come and go with kaleidoscopic rapidity. The individual notes seem to retain their own hues and degrees of brightness, but as a background for the changing colors, there appears, for piano music, a changing blankets of blues and greens. For band music this ''blanket'' is more yellowish.

The following are examples of photisms for tones. As before, the stimuli for the different tests are the same:

	February 9, 1917	August 15, 1919
piano, high tones	brilliant white	a very bright white
medium tones	bluish grey	grey
low tones	dark grey	almost black
Galton whistle	minute sparks of silver colored light	streaks of brilliant ''brightness'' with no color
flute	different shades of blue bordering on violet	faded out blue, higher notes have no color but merely degrees of brightness; not so bright as piano
cornet	beeswax yellow, very bright	yellow; golden color; higher notes almost white; lower notes very pale and darker
full organ	very rich deep black, bluish cast, spots and streaks of brown, with flames of brilliant light irradiating from all sides	very deep chestnut brown, approaching a black, dark bluish or greenish caste

The form and outline of colors for sounds vary greatly from a mere thread-like line or streak to a shapeless "cloud" or "blotch." Sustained tones arouse "extended and thread-like" photisms which become longer as the tone is sustained. Short, quick notes, like staccato notes on the piano, arouse small, short streaks of color, depending upon the length of time the tones are sustained and upon the rapidity with which they follow one another. Large, continuous sounds, as for example a factory whistle, arouse widely expanded areas of color, resembling the side of a hedge or other uniform and solid colored mass. If the whistle is broken up into successive blasts, the "hedge-like" photism is likewise broken up into sections. The organ and cornet photisms are shaped like dominoes or similar bar-like objects. These bars always appear in a vertical position. The violin photisms are similarly bar-shaped but appear slanting upward and to the left. Other instruments produce photisms in a horizontal position. Photisms are not stationary in the visual field. As the reagent's attention shifts from the sound stimulus, for example, the photisms become fainter and travel upward, ultimately merging into a grey background.

The photisms for taste and smell are the most difficult of all for the reagent to describe. This is probably due to several reasons. First, the photism seems to be associated now with the taste of an object and now with its odor. Photisms are becoming confused with retained visual memories or visual associations with the actual objects themselves. When the name of a taste is given as the stimulus there may appear one color which will soon give way to another color of an entirely different hue, as the reagent becomes aware of gustatory or olfactory imagery of the object for which the name stands. The following photisms were reported in a series of tests in which the reagent was asked to recall gustatory and olfactory imagery as the stimuli for the photisms:

	March 9, 1917	August 15, 1919
sour	light grey	muddy grey splotch with upper half quite light, lower half much darker
sweet	yellowish green, very light	pale white, very light
salt	reddish brown, the color of fresh iron-rust	white with several specks and streaks of black running through
bitter	yellowish brown, a little browner than beeswax	yellow, brownish tinge

vinegar	dark green	poorly saturated greenish yellow
quinine	yellow	dark golden yellow
onions	pale buff yellow; the color of manila paper; changed to light blue with olfactory imagery becoming clearer	bright silvery white with occasional streaks of blue
cheese	bright yellowish brown	reddish grey
strawberries	very dark red	rich bluish red, redder than purple
ginger	mahogany red	poorly saturated brown with minute bright specks of white light
ripe peaches	creamy white	light, amber yellow superimposed on a poorly saturated green
pineapple	very dark red	very dark maroon or blackish-red

Introspective reports, similar to the following, indicate that the reagent's color associations for tastes and smells are being confused with possible remnants of visual imagery of the objects themselves. Numerous examples could be given which indicate that the color of the photism has been determined by the color of the object itself. "I perceived the words 'Green prune' and was immediately aware of a small cloud of silvery white light, appearing in front of me and about four feet from my face. I was on the point of reporting 'silvery-white' when I became conscious that this was an old visual remembrance of the inside of a green Italian prune. For some little time I then endeavored to get imagery of the taste of green prunes. When the imagery came the photism changed to a dark blue, almost black with silvery-white streaks running through it. This I recognized as the color of the taste." The colors for many tastes and odors seem hopelessly mixed with visual associations of the objects themselves. Voluntary efforts to visualize fruits and flowers often result in the arousal of colors which oftentimes resemble the photisms for their tastes or odors. It is probable that the colors associated with tastes and smells are influenced, also, by tactual factors.

The colored associates for cutaneous sensations have undergone considerable change during the period of experimentation. Much of this, however, is probably due to finer analysis later in the experiment. The photisms for cutaneous and kinaesthetic pain are often so vivid as to dominate consciousness to the temporary exclusion of any awareness of the pain itself. The colors for cold, hot and pressure are readily obtained by stimulation of any part of the body. The intensity of cutaneous sensations always determines the saturation of the color and the degree of brightness. The coldness of ice-water, whether drunk or applied to the body gives rise to an exceedingly saturated blue, ranging to black. Hot water, at almost a burning temperature gives rise to photisms of "inky black." Hot liquids are disagreeable to drink for the reason that the reagent imagines himself drinking "ink."

	March 9, 1917	August 15, 1919
hot	dark blue, ranging to black	a dark, dirty grey, ranging to black
cold	black	very black, dead, without gloss
pressure	yellow and yellowish brown	yellowish grey, varying degrees of yellow according to intensity of the stimulus
pain	flashes of brilliant light	black

Cutaneous and kinaesthetic blends arouse changing photisms as the blends themselves change. For example when the subject is drying himself after a bath, the body, while wet, is a dark greyish tan which becomes whiter as the drying process continues. Wet tactual impressions are tan or some other shade of brown. A wet portion of the towel, for instance, is darker and browner than the drier portions.

When the reagent attempts to locate places, visually, on the map, they always appear in the same color as is aroused when he hears the name of the place spoken or when he thinks of the place in terms of auditory-vocal-motor imagery of his own voice. When names of places are mentioned orally, to the reagent, the first color to appear is that of the person's voice; when his attention shifts to the name of the place, proper, the photism changes. In the associations of colors with places, there again may be observed the influence of early experiences in the life of the subject. As far back as the reagent can remember, he formed the habit of learning the names of states and their locations on the map by associating them with the colors as they appeared on the map. Evidence of this fact can be found in the subject's tendency to locate places on a map, in colors, whenever the name of the place appears in his consciousness and again in the circumstance that certain states, distributed widely throughout the United States, appear in the same colors. An attempt was made to obtain the geography from which the reagent first studied that subject but a copy of it is not available. This point, therefore, cannot be verified.

The stimulus in each instance for the following reports was the name of the place in question:

	March 9, 1917	August 15, 1919
Oregon	greenish blue, yellow overcast	light yellowish green poorly saturated
Washington	dark bluish green	dark bluish green
California	reddish orange	pale reddish yellow
Texas	very dark drab color	a dirty drab, the color of fir tree trunks
Arizona	color of buck-skin	a bright straw yellow with a tinge of light brown
Utah	dove-grey	dove color with possible light yellowish tinge
Idaho	dove color but lighter than Utah	light smoky blue; faint
Montana	mahogany red	mahogany red, slightly more red than polished mahogany wood
North and South Dakota	light yellow, tinged with a drab-grey	a beeswax yellow
Wyoming	beeswax yellow	faded orange, red almost gone, mostly a tan yellow
Colorado	dove-grey, darker than Utah	dove-grey, dark, almost a slate blue
Kansas	dark tan, like Arizona although somewhat darker	copper shade, dark yellow or reddish tan
Missouri	very dark red, almost black	very dark brown, almost black
Georgia	very light grey, almost white	almost white, background of grey, dominating color is white
Kentucky	blue, very dark	dark bluish black
Ohio	yellow	buff yellow, almost a bright yellow
Virginia	light green	greyish blue-green
Maryland	blue	navy-blue
Rhode Island	white	color of dirty white house
Chile	red	light reddish brown, dominating color, brown
Switzerland	bluish black	a dead bluish black
France	a red mahogany	very rich brownish red

	March 9, 1917	August 15, 1919
Alaska	greenish black as a basic color, bright yellow spots	bright yellow with dark spots
Argentina	tomato red	light tan, streaked and spotted with pink
Ireland	bright yellow	bright yellow, approaching an orange

Color associates for letters and digits are aroused by hearing the name of the letter or digit pronounced, by reading it aloud, or by obtaining tactual impressions in American Braille. The forms of certain of these photisms resemble in shape a figure made by connecting the points of the corresponding braille letters; others have vague resemblances of the printed letters. As time progresses, however, most all of these photisms tend to approach the size and shape of a small square. They are localized from eighteen inches to about two feet from the reagent's face, which suggests the early influence of visualizing reading material.

The following reports were obtained with the names of the letters or digits as stimuli. Tests with American Braille give practically the same results.

	March 9, 1917	August 15, 1919
a	creamy yellow	yellow of rather high degree of saturation, between orange and lemon
b	jet black	very rich and dark bluish black sometimes slightly glossy, almost the black of crow feathers
c	dark silvery grey	light dusty color, too light for smoke or dove color but more like dust on new rubber goods
d	bluish grey	color of bottle-green
e	dull white	a brightness, just light
f	reddish brown	dull brown, poorly saturated, like a faded brown house
g	glossy white	white, or slightly greenish white
h	a foggy, greenish grey	dark, dirty grey, like weather-beaten boards
i	very brilliant white	white, brighter than ''g'' but not as bright as ''e''
j	creamy yellow, different in shape from ''a''	the light yellowish grey of boards, turning old
k	brownish-orange	copper-yellow, carrot-color
m	moderately saturated blue	brown, with yellow tinge, old fallen leaves
n	very light blue, lighter than ''l'' and ''m''	same as ''m'' but lighter and less saturated
l	faded blue	smoky blue, rather pale

	March 9, 1917	August 15, 1919
o	dark muddy color	smutty black, like an old dingy stove
p	pale bluish green	light greenish-blue, washed out in appearance, something like the color of blue-flag
q	dead, smoky black	very dark greenish black
r	black, like "b," but different in shape	the black of a black felt hat
s	light yellow	either a very light yellow or creamy white, color of oil-lamp flame
t	very dark brown	a light chocolate brown
u	tan yellow	greyish yellow, poorly saturated
v	very pale blue	smoky blue, poorly saturated, very light
w	slate grey, larger than "q" and not as dark as "b" and "r"	smudgy, smutty black, like poorly blackened shoes
x	dark brown, two shades	rich black with fringe of red
y	reddish blue, almost violet	color of faded black ink
z	very dark purple	very dark, almost black, tinge of red, not as red as "x"

The colors for digits are similarly fixed over long periods of time. Numbers in the tens class are more richly colored than those in the units class. The photisms for the hundreds class are very poorly saturated. Colors for the thousands class appear on a dark grey background; those for the millions class appear on a bright yellow background. Complex numbers of several digits possess the colors of the component digits and the colors are superimposed upon a background which corresponds to the class indicated by the number of digits. For example, 85 has two colors, the yellowish grey for the 8 and the bluish black for the 5; the colors appear in bars, side by side. 851 has three colors, 8531 has four, and so on.

As a rule, the letters whose sounds are louder, more brilliant, or resonant, are brighter and lighter than the others. The explosive letters, such as b, g, k, p, t, have the greater saturation.

The following are the reagent's reports of his photisms for directions of the compass. The stimuli were the names of the directions. The same colors appear when the reagent is conscious of attending to the same compass directions, whether or not verbal imagery is present in his consciousness.

	March 9, 1917	August 15, 1919
north	black	very rich black, or bluish black
south	yellow	sand-colored yellow
east	red	a reddish brown, bordering on reddish orange
west	brown	little bottle greenish-brown

Foreign words which have become anglosized and English words derived from foreign roots are recognized, by the subject, from their colors. The following are illustrations:

	March 9, 1917	August 15, 1919
German words	dark buff	dark brown, very dark
French words	reddish brown	rich but light brown
Latin words	very dark blue	dark bluish black, the blue very rich
Greek words	white, with faint tinge of blue	a smoky, silvery brightness, bordering on bright grey, almost white

automobile—light blue, chauffeur—reddish brown, conduct—'con' dark blue with 'duct' a shade of brown, pantheist—light steel blue.

The following are color associates which have originated since the subject entered college. The stimuli were the names for different theories or abstract terms, standing for different lines of thought.

	March 9, 1917	August 15, 1919
"Great man" theory in history	very dark brown	dark yellowish grey
"Economic interrelation" theory in history	pale green	poorly saturated and light green
"geographic" theory in history	dark green	very dark bluish green
Weissman theory	dark, glossy, rich reddish brown	strongly saturated reddish brown
behaviorism	drab color	a slaty, bluish black
geneticism	white	a very light, dusty, slightly greenish white

The following are *O*'s reports of colors which are associated with affective and emotional experiences. Tests indicated that the colors which were aroused by associating the name of the experience with the experience itself were as faithful as the colors which appear in the actual presence of the emotion.

	March 9, 1917	August 15, 1919
pleasantness	yellow	light yellow
unpleasantness	blue-grey	dull, dark grey
anger	very intense bluish black ranging to "jet" black	black when there is no muscular movement; action arouses light streaks which run through the black
joy	silvery-grey, ranging to white, according to intensity	yellowish-grey; silver cast

Tones, voices, tastes and odors have been colored as far back as *O* can remember—to approximately five years of age. Digits first became colored when he began to study arithmetic, at the age of seven. It was at this period, also, that number forms originated. Letters, however, were not colored until the subject began to study the point alphabet at the age of eleven, just after becoming blind. Places, such as states and countries, were first colored, as far as the reagent can remember, when he began to study geography in the intermediate grades at school. He derived much help from these colored associates before and after blindness set in. Photisms for systems of abstract thought, theories etc., did not appear until the subject entered college. Each type of color association developed spontaneously, but after its appearance, was voluntarily practiced for the assistance it gave the subject in learning and in reasoning.

Interesting light upon the behavior of these photisms may be found by a reference to the genetic stages of the process of recognizing. When a new sound, whether a person's voice or a nonsense syllable is first heard, a color immediately appears, determined in part by the pitch of the sound, an affective component, if any, or the resemblance of the sound to a familiar one which already has a color. An interesting illustration of this immediate appearance of the color is to be found in the fact that the names of towns, areas, localities etc. in the war zones aroused vivid colors on hearing them for the first time. A second hearing of the same name never failed to evoke the appropriate color. As soon as the subject becomes so familiar with a new name or voice as to be able to get an auditory or verbal image of it, this imagery is appropriately colored. The appearance of the color is a large factor in bringing familiarity with the recalled experience. Subsequently, in the process of forgetting, the vocal-motor or auditory imagery is the first factor to disappear, leaving a feeling of familiarity with its component motor attitude, together with the colored ''blanket.'' For example, after the name of a certain French village in the war territory had been forgotten there was still left the appropriate color for the name of the village. The hue of the color, and the shape and size of the photism then meant to the subject that particular French village. Still later, in the process of forgetting, all associations such as remembrances of events that had taken place in this particular French village disappeared, leaving, in the reagent's recall, only the colored ''blanket'' which was aroused by the general situation, ''village in France'' as the stimulus. The same procedure, in forgetting, is characteristic of other subject matter, such as history, geography, or what not. Still later, in the process of forgetting, the photism itself may become fainter, less saturated, until none of its attributes can be recalled. Many times colors appear in the reagent's consciousness which have lost their original associates and can be identified only as the color for a ''certain person's voice,'' a ''certain place'' whose identity has been forgotten. Thus, in the process of learning and forgetting the objective stimulus appears at the outset with its color. The color is ultimately the last detail of the experience to disappear from the reagent's memory.

The case thus reported presents several peculiar characteristics which have not hitherto been discussed at length in the literature nor have they been subjected to prolonged and intensive laboratory tests. Color associations similar to those of waking life appeared in the dreams of one of the Nussbaumer brothers (103). Our reagent reports similar phenomena. Galton (49) noted that in certain instances number forms had permanent colors as well as numbers. Our reagent has colored number forms in which the numbers are not visualized but are represented by colors or by different shades of brightness. Calkins (20, 21), Hennig (59), Flournoy (46), Lemaitre (81, 84), Grüber (55), Pedrono (106), Mendoza (95) and others have noted that color associations are not confined to the field of perception alone but are also found in the field of imagery. Tendencies to dramatize or to ''personify'' letters, words, numbers and the like may be included in this category as well as photisms or other synaesthetic phenomena in thinking and in dreams. In the case of our observer not only are auditory, tactual and other sensory experiences associated with colors but images of these experiences are associated with identically the same colors. Moreover, the names for different tones, the names of persons whose voices are colored and the names of other sensory experiences suffice, in most instances, to arouse the same colors as do the actual sensory experiences themselves In both instances of imagery and of names only one sensory experience is required before the color is likewise associated, apparently permanently, with the corresponding image or name. It seems probable, therefore, that the same physiological condition which would explain synaesthesia in the field of perception might also apply in the field of imagery.

Since synaesthetic phenomena in the field of imagery to all appearances reveal the same characteristics as do the same phenomena in the field of perception, to regard synaesthesia as belonging to the latter field alone is probably an error. Not all investigators of this problem have reported the fact that the associated image appears in processes of imagining, thinking, etc. A sufficient number of positive cases have been reported, however, to lead one to believe that if all cases had been thoroughly analyzed the same synaesthetic phenomena would have been found in the field of imagery as well as in the field of perception. Several other considerations point to the conclusion that synaesthesis is not a phenomenon of perception alone. First, the color or other associated image may outlive the primary experience in the process of forgetting. Secondly, the photism or associated image may appear in connection with a subliminal stimulus in the absence of the primary sensation. Thirdly, under conditions of fatigue, nervous excitement or of drug taking, the behavior of the secondary image is altered to a greater extent than the behavior of the primary experience. Fourthly, the secondary image shows further, a greater degree of independence of the primary experience than most investigators have apparently assumed, in that when colors for two tones are complementary, these colors tend to follow the first law of color mixture. One investigator (55) found that the photisms tended to follow the second law of color mixture.

A theory of synaesthesis based on laws of reflex action would undoubtedly explain in better fashion the facts of synaesthesis than any theory which confines its interpretations to structural conditions of afferent pathways, to arterial conditions, or to such a general condition as a lack in differentiation of function between adjacent brain areas. We are inclined to the view, therefore, that synaesthesis is a peculiar form of reflex action which, for the sake of a better term, we shall designate as an immediate and permanent "conditioned" reflex. The test of the theory lies in further evidence obtained from experimentation. The view certainly has the advantage of being more flexible than other theories. It is more specific. It accounts better for the fact that one particular color and not another becomes associated with a certain stimulus. Whereas the conditioned reflex as we have come to regard it requires more than one repetition of the stimulus before it is formed, it might be argued that there is no dividing line between various conditioned reflexes which require a shorter or a longer time in becoming established and that in synaesthesis we have an example of a conditioned reflex which is established on the first appearance of the stimulus, instead of on the second, tenth, or fiftieth repetition of the stimulus. We anticipate the objection that conditioned reflexes have an end effect—the secretion of a gland or the contraction of a muscle—and that synaesthesis reveals no such end effect, in answer to which we can only reply that for the sake of clear thinking, this view of synaesthesis assumes that mental processes are responses—forms of implicit behavior—which can be described in terms of laws similar to those laws by which we describe overt behavior. In synaesthesis, the end effect would be the associated image.

But we have speculated too much already. We must know more facts. The phenomenon of synaesthesis presents an exceedingly rich field for further experimentation. It should be studied genetically, with emphasis upon the behavior of the phenomenon. We have gone into the history of the problem in some detail in order to make this paper the first of a series of articles bearing upon experiments on Mr. Cutsforth.

An intensive study of synaesthesis should prove fruitful of many practical results both for general and applied psychology.

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Note. From time to time there have appeared discussions of synaesthesia in the popular literature. Because such articles contain so little of scientific interest or worth they have not been here reviewed. We mentioned in the text of this paper that attempts had been made to associate colors with music during a musical performance, by means of a color organ. On March 20, 1915, in New York, the Russian Symphony Orchestra presented Scriabine's ''Prometheus,'' with colors. A few years previous to this A. Wallace Rimington experimented with a color organ, in London. Accounts of the color organs, and the success or failure of the experiments from the standpoint of art are discussed in certain of the following popular articles:

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FOSSIL MOLLUSKS FROM THE JOHN DAY BASIN IN OREGON

CONTAINED IN THE CONDON MUSEUM OF THE UNIVERSITY OF OREGON

BY
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INTRODUCTION

Through the courtesy of Dr. Earl L. Packard, of the Department of Geology, University of Oregon, I have had an opportunity to study the collection of fossil land shells in that institution from the John Day Basin, eastern Oregon. It was assembled by Prof. Thomas Condon, the discoverer of the famous deposits of mammal remains in Oregon. Altogether there are 118 specimens in the collection. Many of them are fragmentary or immature and cannot be identified with certainty. Eleven species are represented, two of which are believed to be new. These belong to genera found for the first time in the Miocene deposits of the western United States and one of them was not previously known to exist in North America, either Recent or fossil. The collection also includes specimens of species which were previously known only from type specimens. The collection is therefore one of the most important which has come to light from this region.

In order that references to all of the described John Day species may be available to western students there has been added to the account of this collection a review of all known published records. This has been compiled from the author's card index.

The collecting of mollusks in the region has apparently been merely an incident to those persons in search of mammal remains and as a consequence definite stratigraphical data have not been recorded. This is unfortunate because it makes it impossible to assign the several species to the geologic subdivisions recognized by the vertebrate paleontologists. No doubt much in the way of correlating this deposit with those elsewhere can be accomplished when the region shall be explored with mollusks the chief objects in mind.

SPECIES IN THE UNIVERSITY OF OREGON COLLECTION

Gastrodonta imperforata Hanna

Plate 1, figures 1*a* and 1*b*

One of the four specimens of this species in the collection is almost perfect and is figured in two views because of its superiority to the type. The axis is completely imperforate and there is a peculiar twist to the columellar wall which recalls *Sagda* of the West Indies. It may in fact prove to be that the John Day shells belong in or near that genus but the evidence is not considered sufficient to warrant such disposition at present. The shell substance of *G. imperforata* is exceedingly thin and delicate and the growth striae are uneven and rather coarse. No trace of spiral striation can be found.

Epiphragmophora antecedens Stearns

Two imperfect specimens and two fragments have been referred to this species. In no case is the aperture preserved so the identification is somewhat doubtful.

Epiphragmophora dubiosa Stearns

Two imperfect specimens are in the collection.

Epiphragmophora marginicola (Conrad)

The finding of a specimen of this, the first John Day shell to be described, is very interesting. Conrad's type was a young shell as shown by his figure and his description was so meager that identification therefrom seemed hopeless. He says ''Depressed; spire scarcely raised above the margin of the last volution; whorls 6, convex-depressed; shoulder of last whorl subangular; umbilicus small; aperture obliquely subquadrate. Locality, Bridge Creek, Oregon."*

The University of Oregon specimen conforms to the above description almost precisely although it is imperfect. The last whorl at least is missing so that the character of the completed aperture cannot be ascertained and it is believed Conrad's shell was in the same condition. It was thought possible that we actually had here his type, so great is the resemblance, and this may in fact be the case. But if so his drawing fails to show the remnants of a broken whorl about the margin. The shell appears to belong to the Helicidae and it is believed that when a complete specimen is available it will be found to be related to the *mormonum* group of *Epiphragmophora.* The genus *Zonites* in which the species was originally placed is not now recognized as having existed in the United States and the shell certainly does not furnish any evidence to show that it belongs to that family.

Polygyra dalli (Stearns)

By far the greater part of all land shells thus far collected in the John Day region belong to this species. The University of Oregon Collection contains 90 shells which have been referred here; among them are many which are well preserved. Many others are fragmentary or young and therefore they have been identified with doubt.

Polygyrella polygyrella (Bland and Cooper)

This species lives in the mountains of Idaho at the present time but it was with considerable surprise that a specimen was found in the Oregon Miocene. The shell is not perfect; one whorl at least has been broken away but the characters of *Polygyrella* are well exhibited. It seems to be somewhat larger than the Recent *P. polygyrella* with the same number of whorls but there is considerable variation in this respect in Recent shells. Perhaps when the aperture shall have been found intact the fossil form will be found to be distinct but without this portion of the shell it is best considered to be the same.

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*Conrad, T. A., Am. Jour. Conch. Vol. 6, 315, p. 13, fig. 9. 1870-71

Ammonitella lunata (Conrad)

Ten more or less imperfect specimens are in the University of Oregon Collection.

Pyramidula mascallensis Hanna

Four imperfect specimens are in the collection. They exhibit the very flat character of the whorls above in excellent manner.

Oreohelix lecontei Stearns

One specimen with four and a half whorls intact is in the collection. At least one complete whorl has been lost. And the very thin shell substance has been lost on all but the first three whorls.

Helicina oregona n. sp.

Plate 1, figures 3*a*, 3*b* and 3*c*

Shell consisting of a little over six whorls with the sutures between them but little impressed. Spire elevated and sides somewhat convex. Last whorl not depressed below the margin of the one preceding. Spire covered with a thin layer of material which is uniformly raised into ribs and of which there are nine or ten to the millimeter on the last whorl. These ribs do not extend to the base of the shell. Aperture oblique, about 45 degrees with the axis. Outer lip reflected and thickened outside with callous material. The columella makes a peculiar twist at its junction with the base of the shell. This junction is slightly below the level of the base when viewed spire down. There is no definite carina at the margin of the body whorl.

Measurements of type: greatest diameter 7.2 mm.; least diameter, 6.0 mm.; altitude parallel to axis 4.5 mm.

Type number 12, University of Oregon Collection from the John Day Oligocene (?). No other specimens.

The type is very well preserved and does not seem to be closely related to any other known *Helicina*. The presence of the genus in the Oligocene of the United States has not previously been known and it is another instance of tropical forms which flourished much north of their present range at that time. The ribbed surface of the shell recalls *H. rugosa* of Jamaica and *H. rugulosa* of the Society Islands but it is not in reality closely related to either of these forms. Neither does it resemble except in gross characters the United States Recent species *H. occulta* and *H. orbiculata,* and the fossils *H. ballista* and *H. tampae* of Florida. It is one of the most interesting Tertiary land shells thus far found, ranking with *Ammonitella, Boysia, Protoboysia, Helicostyla* and *Rhiostoma.*

Rhiostoma americana n. sp.

Plate 1, figures 4*a* and 4*b*

Shell composed of three whorls, the last increasing in size very rapidly and projecting free of the spire. Spire elevated conic with the whorls angulated acutely. Sutures deeply impressed. A revolving lamella on the palatal wall of the last whorl continuing and increasing in size to the aperture where it probably formed a tooth. The columellar wall also had a tooth. The junction of the columellar and basal walls acutely angular at the aperture. Umbilicus apparently widely open.

Measurements of type: greatest diameter, 8.50 mm.; least diameter, 5.0 mm.; altitude parallel to axis 7.0 mm. (The measurements of a complete shell would somewhat exceed these.)

Only the type specimen has been found. It is from the John Day Oligocene (?) and is deposited in the University of Oregon. (Type number 13). Unfortunately it is largely a cast and leaves much to be learned of the shell. However the characters are so unique that no hesitancy is felt in making it the type of a new species. Its resemblance to the Siamese *Rhiostoma* Benson is close and although the complete shell may show that it does not belong in that genus it seems best to so refer it now. It is not related to *Boysia* and *Protoboysia,* genera with Indian affinities first added to our fauna in 1914.*

The finding of this, apparently a land operculate with living Asiatic relatives, in the United States Oligocene (?) is very remarkable and furnishes a basis for much interesting speculation. The groups of mollusks which then lived here are no less strange to the conchologist than the mammals are to the mammalogist.

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*Cockerell, T. D. A., Land Shells from the Tertiary of Wyoming. Bull. 33 Amer. Mus. Nat. Hist. p. 323, 1914.

SYNOPSIS OF JOHN DAY LAND AND FRESH-WATER MOLLUSKS

For full accounts of the geological, stratigraphical, and paleontological features of the region see, Merriam, J. C., A Contribution to the Geology of the John Day Basin; University of California Publications, Bulletin of the Department of Geology, vol. 2, No. 9, pp. 269-314, April 1901. Also, same author, and same series of publications, vol. 5, No. 1, pp. 1-64, December, 1906. Also Merriam and Sinclair, Tertiary Faunas of the John Day Region; same series, vol. 5, No. 11, pp. 171-205, October 1907. The latter has a fairly complete bibliography.

Ammonitella lunata (Conrad)

Planorbis (*Spirorbis?*) *lunatus*. Conrad, Am. Jour. Conch. Vol. 6, p. 315, pl. 13, fig. 8, 1870-71. (Condon Collection. Bridge Creek, Oregon).—White, 3rd. Ann. Rep. U. S. Geol. Surv. p. 448, pl. 32, figs. 24-25, 1880-81. Hannibal, Proc. Mal. Soc. London, Vol. 10, p. 159, 1912. (The species here is rightly ascribed to *Ammonitella* and considered distinct from *A. yatesi* Cooper, a Recent species. Stearns name was made synononous. The species is stated to be from ''Oligocene, John Day series, Oregon.'')

Gonostoma yatesi (Cooper) Stearns, (in White). U. S. Geol. Surv. Bull. 18, p. 16, pl. 3, figs. 8-12, 1885. Cope and Condon collections.

Ammonitella yatesi praecursor Stearns. Proc. Wash. Acad. Sci. Vol. 2, p. 656, pl. 35, figs. 8.12, 1900. (Same figures reproduced as in U. S. Geol. Surv., Bull. 18, cited above.)—Stearns, Science n. s. Vol. 15, p. 153, 1902. (Mentioned as in the University of California Collection.)—Stearns, Univ. of Calif. Publ. Geol. Vol. 5, No. 3, p. 67, 1906. (Mentioned).

Ammonitella lunata (Conrad) Hanna, Kans. Univ. Sci. Bull., Vol. 13, p.... (In the University of Kansas Collection). Mentioned herein as being in the University of Oregon Collection.

Epiphragmophora antecedens Stearns.

Helix (*Aglaia*) *fidelis* Gray. Stearns, (in White) U. S. Geol. Surv. Bull. 18, p. 14, pl. 3, figs. 1-3, 1885.

Epiphragmophora fidelis antecedens Stearns. Proc. Wash. Acad. Sci. Vol. 2, p. 653, pl. 35, figs. 1-3, 1900. (Same figures reproduced as in U. S. Geol. Surv. Bull. 18, cited above.)—Stearns, Science, n. s. Vol. 15, p. 153, 1902. (Mentioned as in the University of California Collection.)—Stearns, Univ. of Calif. Publ. Geol. Vol. 5, p. 67, 1906. (Mentioned.)

Epiphragmophora antecedens Stearns. Hanna, op. cit. (Mentioned as in the collection of the University of Kansas.)—Mentioned herein as being in the University of Oregon collection.

Epiphragmophore dubiosa Stearns. Science, n. s. Vol. 15, p. 153, 1902. (Original description.) (In the University of California Collection.) Stearns, Univ. of Calif. Publ. Geol. Vol. 5, p. 69, figs. 3-4, 1906. (Original description repeated and figures provided.)—Hanna. op. cit. (Mentioned as being in the University of Kansas Collection.)—Mentioned herein as being in the University of Oregon Collection.

Epiphragmophora marginicola (Conrad).

Helix (*Zonites*) *marginicola* Conrad Am. Jour. Conch, Vol. 4, p. 315, pl. 13, fig. 9, 1870-71. (Bridge Creek, Oregon, Condon Collection. White, 3rd Ann. Rep. U. S. Geol. Surv. p. 453, pl. 32, fig. 34, 1880-81.

Epiphragmophora marginicola Conrad. Mentioned herein as being in the University of Oregon Collection.

Gastrodonta imperforata Hanna, op. cit.
(Original description.)—Mentioned herein as being in the University of Oregon Collection.

Helicina oregona n. sp. Described herein.

Lymnaea stearnsi Hannibal.

Limnaea maxima Stearns, Science, n. s. Vol. 15, p. 154, 1902. Stearns, Univ. of Calif. Publ. Geol. Vol. 5, p. 70, fig. 1, 1906.

Lymnaea stearnsi Hannibal. In Baker, Lymnaeidae of N. and Mid. America, p. 102, pl. 17, fig. 11, 1911. (New name for *L. maxima* Stearns, a name used in varietal sense by Collin, Ann. Soc. Mal. Belg. 7, p. 94, 1872.)—Hannibal, Proc. Mal. Soc. Lon. 10, p. 143, 1912. (Mascall Miocene).

Oreohelix lecontei Stearns. Science, n. s. Vol. 15, p. 154, 1902. Stearns, Univ. of Calif. Publ. Geol. Vol. 5, p. 68, fig. 2, 1906. Mentioned herein as being in the University of Oregon Collection.

Polygyra dalli (Stearns.)

Helix (*Monodon*) *dalli*, Stearns, (in White) U. S. Geol. Surv. Bull. 18, p. 14, pl. 3, figs. 4-6, 1885. (In a later publication Stearns says the word *Monodon* was an error for *Mesodon*.)

Polygyra dalli Stearns, Proc. Wash. Acad. Sci. Vol. 2, pl. 35, figs. 4-6, 1900. (Same figures reproduced as in White, cited above. Stearns, Science, n. s. Vol. 15, p. 153, 1902. Mentioned as being in the University of California Collection.) Stearns, Univ. of Calif. Publ. Geol. Vol. 5, No. 3, p. 67, 1906. Hanna, op. cit. (Mentioned as being in the University of Kansas Collection.) Mentioned herein as being in the University of Oregon Collection.

Polygyra expansa Hanna. Op. cit.

Polygyra martini Hanna. Op. cit.

Polygyrella polygyrella (Bland and Cooper.) Mentioned herein as being in the University of Oregon Collection.

Pyramidula mascallensis Hanna. Op. cit. Mentioned herein as being in the University of Oregon Collection.

Pyramidula simillima Stearns.

Helix (*Patula*) *perspectiva* Say. Stearns. (in White.) U. S. Geol. Surv. Bull. 18, p. 14, pl. III, fig. 7, 1885.

Pyramidula perspectiva simillima Stearns, Proc. Wash. Acad. Sci. Vol. 2, p. 657, pl. 35, fig. 7, 1900. (Figure reproduced from U. S. Geol. Surv. Bull. 18 cited above. No description added.) Stearns, Science, n. s. Vol. 15, p. 153, 1902. (No description.) Stearns. Univ. of Calif. Publ. Geol. Vol. 5, p. 67, 1906. (This is a nude name and cannot hold in nomenclature.)

Rhiostoma americana n. sp. Described herein.

Unio condoni White, U. S. Geol. Surv. Bull. 18, p. 13, pl. 2, figs. 1-3, 1885.
Migranaja condoni (White.) Hannibal, Proc. Mal. Soc. Lon. Vol. 10, p. 124 and 197, 1912.

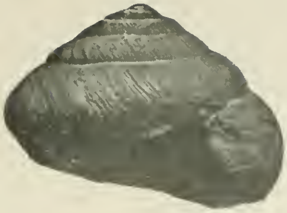
Transmitted May 27, 1920.
Issued August 26, 1920.

EXPLANATION OF PLATE I

Figures 1*a*, and 1*b*. *Gastrodonta imperforata* Hanna. Enlarged approximately 1¾ times.

Figures 3*a*, 3*b*, and 3*c*. *Helicina oregona*, n. sp. All enlarged approximately six times.

Figures 4*a*, and 4*b*. *Rhoistoma americana*, n. sp. Both enlarged approximately six times.



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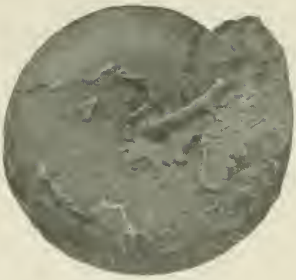

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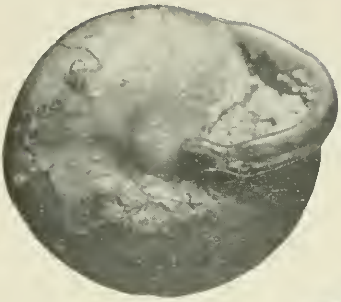

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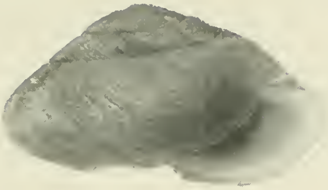

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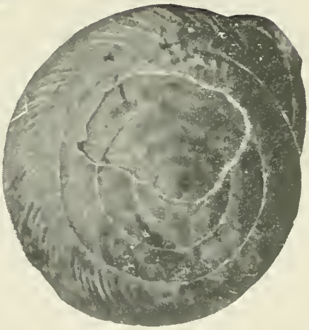

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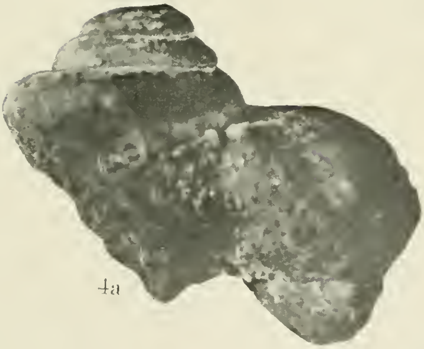
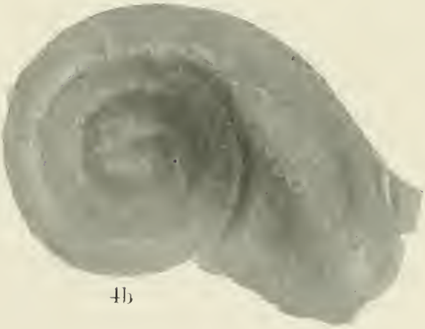


4a



4b

PLATE I.

UNIVERSITY OF OREGON PUBLICATION
Vol. I. September, 1920 No. 7

A STUDY OF THE MENTAL, PEDAGOGICAL AND PHYSICAL DEVELOPMENT OF THE PUPILS OF THE JUNIOR DIVISION OF THE UNIVERSITY HIGH SCHOOL, EUGENE, OREGON

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OUTLINE

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  - A. Statement of the Problem.
  - B. Nature and Scope of the Investigation.
- Section II. Tests of General Intelligence.
  - A. Individual.
    - 1. Stanford Revision of Binet-Simon Tests.
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    - 1. Army Group Examination Alpha.
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  - C. Teachers' Estimates.
- Section III. Acceleration, Retardation, and School Progress.
- Section IV. Measures of School Attainment.
  - A. School Marks.
  - B. Standard Educational Tests.
    - 1. Courtis Standard Research Tests in Arithmetic.
    - 2. Kansas Silent Reading Tests.
    - 3. Gregory Language Tests.
    - 4. Ayres Spelling Lists.
    - 5. Ayres Handwriting Scale.
    - 6. Douglass Standard Diagnostic Algebra Tests.
- Section V. Anthropometric Measurements.
  - A. Height.
  - B. Weight.
  - C. Lung Capacity.
  - D. Strength of Grip.
- Section VI. Correlations, Discussion, and Conclusions.
  - A. Reliability of Tests of Intelligence in Comparison with Teachers' Estimates.
  - B. Use of Tests as a Basis for Special or Forced Promotions.
  - C. Relation of Intelligence to Retardation.
  - D. Physical Factors in Relation to School Work.
  - E. Correlations in School Abilities.
  - F. Establishment of Just Standards for School Accomplishment.
  - G. Conclusion.

SECTION I.

INTRODUCTORY

The Problem

The purpose of this investigation is that of suggesting in several directions how the methods of the scientific study of educational problems through the medium of the various tests of general intelligence, pedagogical attainment, physical development, and the like, can be applied to the practical problems of school administration.

The position is taken here that these types of objective measurements mentioned above, although admittedly as yet in the experimental stage, can furnish data of the greatest value in supplementing the traditional methods long in use as the basis for promotions, assignment of school marks, establishment of just standards of attainment, and many other similar problems of the administrator and teacher. It should be emphasized at the outset that it is not the purpose or spirit of this discussion to advocate the substitution of new and not thoroughly established practices for those methods which time has perfected and found valuable, but rather, to advocate the addition of these newer methods as supplementary sources of knowledge and thus make surer the validity of our school room practices. An imperfect tool is often better than no tool at all and a new tool of inferior design is often more serviceable than a once-excellent old instrument. What is needed is a judicious use of both the old and the new methods of educational practice.

Nature and Scope of the Investigation

The experimental work reported here is confined to the three grades of the junior division of the University High School at Eugene, Oregon. These are the three years of the typical junior high school under the 6-3-3 plan, *i. e.*, extending from the seventh up to and including the ninth grades. The classifications dealing with age and grade and practically all of the tests were made during the second semester of the school year 1919-20. In a very few cases the data were obtained late in the year 1919. In the grades included there are about one hundred and twenty-five pupils ranging in age from less than twelve years to twenty years in one case.

The pupils of the University High School are practically an unselected group as far as entrance restrictions or preferences for admission are concerned. In accordance with an agreement entered into with the school authorities of the city schools of Eugene, the University High School draws from a certain section adjacent to the school in much the same way as do the other separate schools of the city. However, in spite of this arrangement, the students of the school represent a composite group composed of two distinct and very different elements. The first element comprises the pupils from the homes of people professionally connected with the State University. Since the school is an integral part of the School of Education of the University and is located on the campus in the building primarily used for the Department of Education, the University High School quite naturally draws heavily from faculty homes. It will be shown later that intellectually and culturally these pupils are above normal. The other element presents a sharp contrast in that this group of pupils represents homes that are socially and economically somewhat inferior, if anything, to those of certain other districts of the town. The parents of this second group are to a large extent day laborers and chiefly of the unskilled type. Although neither of these groups is numerically large, they do act as selective agencies which must later be taken into account in certain of the findings discussed in this paper.

The tests given fall into three classes:

1. Tests of general intelligence.
2. Standard educational tests.
3. Physical or anthropometric measurements.

In each case several different types of tests are given and these will be discussed under the appropriate headings in later sections of this study. The final section will deal with the attempt to correlate and classify these diverse measurements, to show their administrative implications, to suggest problems which can be attacked by this method, and, finally, to draw certain conclusions apparent in the statistical treatments used here which are of interest to school administrators and teachers in the public schools, particularly in junior high schools.

Specific acknowledgments for assistance in the work reported here are numerous since the detailed experimentation was done at all times in a co-operative way. Especially was the assistance of Professor H. R. Douglass of the Department of Education of the greatest value at all times, both in a material way and for helpful criticisms. Together with Mr. Peter L. Spencer, the former is chiefly responsible for the section on standard educational tests.

Miss Lexie Strachan, Mr. George E. Finnerty and the writer gave the individual Binet examinations. The first two mentioned worked under the direct supervision of Professor B. W. DeBusk of this department. Mr. Finnerty also assisted with the physical measurements for the boys and Professor Harriet W. Thomson of the Department of Physical Education for Women of the University kindly gave the services of her class in anthropometry for the physical measurements of the girls. Miss Strachan also checked some of the statistical treatments. The following members of the University High School staff made the estimates of intelligence quoted in Section III: Professor Douglass, Mrs. Geo. B. Goodall, Mrs. Edith B. Pattee, Mrs. Geo. S. Bendshadler, Mr. Victor P. Morris and Mr. Peter L. Spencer.

SECTION II.

TESTS OF GENERAL INTELLIGENCE

For the purposes of this investigation it was finally decided that the Binet-Simon tests as revised and extended by Dr. L. M. Terman and his associates offered the highest degree of reliability of any single criterion of native ability or general intelligence. These tests have been carefully standardized and have the additional advantage of having been widely used upon California and eastern children. If marked sectional differences exist in the results of the use of intelligence tests, Oregon children would be likely to resemble California school pupils more closely than those of eastern states.

The tests were in all cases given in a quiet room with only subject and examiner present. Care was taken to establish a good working ''rapport'' between the pupil and the examiner. The examiners were in all cases persons trained in psychological methods and the technique of intelligence testing. In cases of doubtful points in scoring all three examiners joined in arriving at an agreement. With few exceptions the responses of the pupils were recorded verbatim upon the regular test forms supplied by the author of the tests.

The group tests used were two in number, the Army Group Examination Alpha and the Chicago Group Intelligence Test devised by Freeman and Rugg. In each case the exact directions furnished by the authors were followed without deviation. It was the original intention to use other group tests as supplementary and corroborative data, but this was later given up because of the marked danger of introducing practice effects since there is a considerable degree of similarity between most of the group tests in use today. The sizes of the groups taking the tests varied from ten to sixty, but at no time was a larger number tested at any one time. A large well-lighted room with arm-rest chairs was used for the examinations. All of the group tests were given by the writer with one or more assistants present to supervise the work. It is interesting to record that not a single attempt at cheating was noted by the examiners in any of the tests.

It is not thought that group tests do more than approximate the accuracy of the individual examinations but they do possess certain advantages from the administrative point of view which weigh heavily in actual school practice, *viz.*, the great economy in time consumed in giving the tests. A group of one or even two hundred pupils may be tested in forty-five minutes with the Alpha test or in slightly less than thirty minutes with the Freeman-Rugg scale. It would therefore be possible to test entire schools where the enrollment does not exceed the number stated above at one time. An hour's time cannot well be held to be prohibitive, and there are few sources of information of vital significance which are more economical in time or effort expended. More will be said later on upon the topic of the practical applications of intelligence ratings.

Tables 1-10 and graph 1 summarize the various findings and are self-explanatory for the most part. Table 1 gives the classification of the degrees of intelligence as tentatively suggested by Professor L. M. Terman of Stanford University.

TABLE 1

TERMAN'S CLASSIFICATION OF THE INTELLIGENCE QUOTIENTS*

I. Q.	*Classification.*
Above 140	"Near" genius or genius.
120-140	Very superior intelligence.
110-120	Superior intelligence.
90-110	Normal, or average intelligence.
80-90	Dullness, rarely classifiable as feeble-mindedness.
70-80	Border-line deficiency, sometimes classifiable as dullness, often as feeble-mindedness.
Below 70	Definite feeble-mindedness.

In the tables of the distributions of the scores which follow, the scores for the Army Alpha are in all cases the "raw" scores; in the

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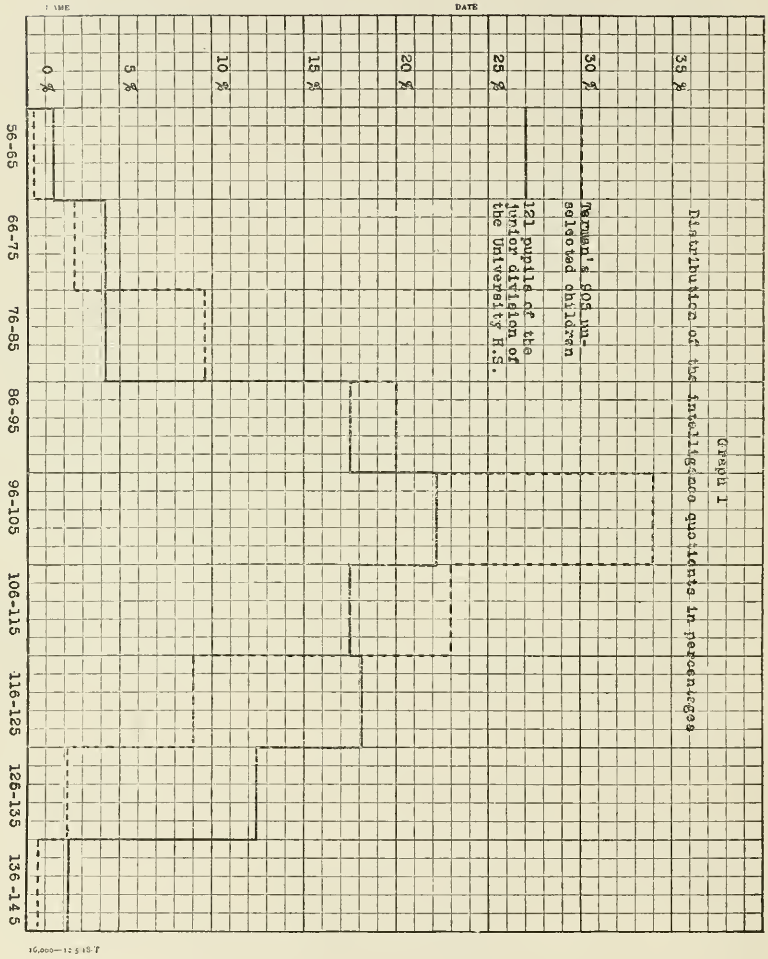
*TERMAN, L. M.: The Measurement of Intelligence, Houghton Mifflin Co., Boston, 1916, p. 79.


NAME
DATE
Graph I
Distribution of the intelligence quotients in percentages
Terman's 905 unselected children
121 pupils of the junior division of the University H.S.
0 %
5 %
10 %
15 %
20 %
25 %
30 %
35 %
56-65
66-75
76-85
86-95
96-105
106-115
116-125
126-135
136-145
16,000—1:5 18 T

Freeman-Rugg tests, the scores are weighted according to their standards. The number of pupils included varies from 116 to 121 in the separate distributions since a very few pupils missed one or more of the tests due to absence from school. One hundred and sixteen took all three intelligence tests.

Table 6 shows the comparative reliabilities of the two group tests as shown by the degree of correlation existing between them and the mental age ratings of the individual Stanford Binet tests. The reliability of the Alpha test appears to be somewhat greater, the Pearson coefficient of correlation being 0.73 in comparison with 0.62 for the Chicago scale. It should be remembered at this point that the latter is a briefer test from the standpoint of the time used in giving, and that this fact would, everything else being equal, explain any small difference in the reliability of the tests. The same table shows that the individual tests of the two scales show similar differences in the size of the coefficients of correlation in favor of the army tests.

Tables 8 and 9 are devoted to the question of the reliability of teachers' estimates. Table 8 shows the results of six experienced teachers' ratings under very, if not unusually, favorable circumstances. The six teachers making the ratings were all intimately acquainted with the pupils rated, in fact, they were instructed to omit from consideration any pupils with whom they were little acquainted and where the ratings would be little more than guesses. The instructions were to assign each pupil of the school a rank of from I to X in the order of the most intelligent to the dullest. These ten groups were then re-ranked within the groups and the pupils numbered 1, 2, 3, etc. Thus it was possible to arrange all the pupils of the school into one list. It must be noted that the procedure in obtaining these ratings was very different from that used by most investigators in that the instructions included a number of specific cautions against certain typical forms of error likely to arise in estimating intelligence. The teachers were warned against the following:

1. Always consider *age in relation to grade*. A pupil might appear more intelligent than most of his class because of being two or more years older than his fellows and be in reality a dull rather than a bright pupil. (The exact age to the nearest month was furnished on the lists given to each teacher.)
2. Bright looks, vivacity, snappiness of manner, alertness, sparkling eyes, bluff, loquacity, etc., often pass for intelligence.
3. Good work habits, high grades, etc., often pass for ability. Likewise the tendency is to underrate the lazy pupil.
4. Disciplinary considerations often influence the teacher making the rating.

Under the circumstances as described in the foregoing it is not surprising that the teachers' ratings show such high degrees of reliability as is evidenced by the correlations of table 8. In some cases the individual teachers used several hours in the course of arriving at the estimates. In view of these considerations, it seems entirely likely that our results represent a close approximation to the best results to be obtained by the method of estimation. Terman and Proctor* did not report such high coefficients as our study, the combined estimates showing an *r* equal to 0.59 in comparison with 0.68 for the pooled results of the six University High School teachers. The average *r* was likewise 0.68.

In order to compare the results of inexperienced teachers with those of the regular staff of the school, ten practice teachers were asked to rate the pupils of their own classes. No cautions or explanations which were of value in guarding against errors were given this group of teachers, mostly University seniors. Table 9 gives the results of their estimates. Here the average is approximately 0.50. Aside from the directions given to the regular teachers, the practice teachers worked under more favorable conditions since they rated only pupils in their own classes and in all cases the numbers were much smaller. As has often been pointed out correlations of the inexperienced teachers' ratings with school marks are almost certain to prove greater than such ratings with the results of intelligence tests, showing that school work is a chief basis for such estimates. In the case of practice teacher ''J,'' these correlations are, respectively, 0.68 and 0.26.

Table 10 is included as a presentation of the displacement of pupils by the method of estimates from the order determined by the use of the Binet tests upon the rough assumption that the groups I to X of the estimates correspond to certain ranges of the I. Q. Less than one-fifth of the pupils appear to be correctly located (16.9 per cent) but about three-fifths are correctly located or not seriously displaced (61.3 per cent no more than one group). However, a displacement of two or more groups occurs almost two out of five times (38.9 per cent) and this amount of error might in extreme cases displace a pupil for a distance equal to that of the difference between the highest and lowest quartiles at certain parts of the range. More will be said at a later time about the possibility of teachers' estimates approximating the value of the tests of intelligence.

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*Terman, L. M.: The Intelligence of School Children, Boston, 1919, Houghton Mifflin, pp. 84-86.

TABLE 2

Showing the distribution of mental and chronological ages of 121 pupils of the junior division (grades 7-9 inclusive).

Age	9	10	11	12	13	14	15	16	17	18	19	20
C. A.	0	0	4	24	37	24	18	7	5	0	1	1
M. A.	1	4	6	8	19	30	18	18	12	5	0	0

TABLE 3

Showing the distribution of the scores in Army Alpha for the three grades of the junior division.

0-19	20-39	40-59	60-79	80-99	100-119	120-139	140-159
1	2	13	27	29	24	15	5

TABLE 4

Showing the distribution of the scores in the Chicago Group Intelligence Test for the three grades of the junior division.

0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79
1	12	22	31	27	12	11	2

TABLE 5

Showing the median scores in the several intelligence tests for the three grades of the junior division.

C. A.	M. A.	I. Q.	Alpha	Chicago
13-11	14-9	107.0	89.0	38.0

TABLE 6*

Showing the Pearson coefficients of correlation between the mental ages obtained by the Stanford Revision of the Binet-Simon tests and the two-group scales.

	r	*P. E.*
Army Group Examination Alpha	0.728	.033
Chicago Group Intelligence Test	0.622	.038

The separate tests:

		Chicago			*Army Alpha*	
		r	*P. E.*		*r*	*P. E.*
"Opposites"	(1)	0.372	.053	(4)	0.596	.042
"Number Completion"	(2)	0.368	.054	(5)	0.418	.052
	(3)	0.479	.048			
"Analogies"	(4)	0.475	.048	(7)	0.460	.050
"Best Reasons"	(5)	0.400	.052	(3)	0.456	0.50
No. pupils		118			116	

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*Ruch, G. M. and Strachan, Lexie: A Comparison of Intelligence Ratings Obtained by the Use of Two Group Scales with those of the Stanford Revision of the Binet Tests. To appear in the Journal of Educational Psychology, October, 1920.

TABLE 7

Showing the distribution of the I. Q.'s for the 121 pupils of the junior division of the University High School, Eugene, Oregon, in absolute numbers and percentages, in comparison with the distributions for Terman's 905 unselected children* and Chase and Carpenter's composite group at Chapel Hill, North Carolina.†

I. Q.	University High School		Terman	Chapel Hill
	Absolute Numbers.	*Percentages.*	*Percentages.*	*Percentages.*
56-65	2	1.4	0.33	1.5
66-75	5	4.2	2.3	7.7
76-85	5	4.2	8.6	20.0
86-95	21	17.4	20.1	43.1
96-105	27	22.3	33.9	23.1
106-115	21	17.4	23.1	4.6
116-125	22	18.2	9.0	0.0
126-135	15	12.4	2.3	0.0
136-145	3	2.5	0.55	0.0

TABLE 8

Showing the correlations of the individual teachers' estimates and the pooled estimates of the six teachers with the intelligence quotients as obtained by the Binet tests.

Teacher	*r*	*P. E.*	*N.*
A	0.70	.041	72
B	0.71	.034	96
C	0.72	.060	29
D	0.70	.051	45
E	0.66	.044	75
F	0.61	.047	80
Pooled	0.68	.037	95
Average	0.68		

TABLE 9

Showing the correlations of ten individual practice teachers' estimates of intelligence with the I. Q. of the Binet tests.

Teacher	*r*	*P. E.*	*N.*	*Subject Taught*
A	0.54	.108	20	Biology
B	0.16	.170	15	English
C	0.76	.063	20	General Science
D	0.46	.140	14	General Science
E	0.54	.195	6	French
F	0.48	.122	18	Algebra
G	0.36	.170	12	English
H	0.67	.166	5	French
I	0.76	.078	13	General Science
J	0.26	.113	31	Art
Average 0.495.				

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*Terman, L. M.: The Measurement of Intelligence, Boston, 1916, Houghton Mifflin Co., p. 66.

†Chase, H. W. and Carpenter, C. C.: The Response of a Composite Group to the Stanford Revision of the Binet-Simon Tests, Journal of Educational Psychology, 10, 1919, pp. 178-188.

TABLE 10

Showing the displacement of pupils in terms of the number of groups which would result upon the basis of the use of the pooled estimates of six experienced teachers working under the most favorable circumstances ($r=0.68$ with the I. Q.).

		Displacement in terms of groups.					
Group.	*I. Q.*	*0*	*1*	*2*	*3*	*4*	*5*
I. Corresponding to	140 or above	1	4	3	2	0	0
II. Corresponding to	130-139	1	5	4	3	0	0
III. Corresponding to	120-129	4	7	4	2	2	0
IV. Corresponding to	110-119	2	8	2	1	0	0
V. Corresponding to	100-109	5	6	2	0	0	0
VI. Corresponding to	90- 99	1	6	1	0	1	0
VII. Corresponding to	80- 89	0	4	2	0	0	0
VIII. Corresponding to	70- 79	0	1	3	3	0	0
IX. Corresponding to	60- 69	2	0	0	0	0	0
X. Corresponding to	Below 60	0	1	1	1	0	0
Totals ($N=95$)		16	42	22	12	3	0
In percentages		16.9	44.2	23.2	12.6	3.1	0.0

Summary

Percentage correctly located (no displacement)	16.9
Percentage displaced not more than one group	61.1
Percentage displaced more than one group	38.9
Percentage displaced more than two groups	15.8
Percentage displaced more than three groups	3.1

SECTION III.

ACCELERATION, RETARDATION, AND SCHOOL PROGRESS.

In the tables which follow, particularly the age-grade table, acceleration and retardation were determined upon the basis advocated by Dr. L. P. Ayres[*] with one slight modification, *viz.*, in locating age according to grade the pupil was considered to be at the age in which 50 per cent or more of the year's work for that grade was done instead of using the September-entering ages as most others have done. This is obviously somewhat truer to the facts and is advantageous in certain comparisons in which the exact age in years and months must be used. Table 11 gives the age-grade distribution for the three grades, in actual numbers and percentages, and by sexes. Summaries of the same data are given in tables 12 and 13.

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[*] Ayres, L. P.: Laggards in Our Schools, N. Y., Russel Sage, 1909.
[†] Ibid., p. 45.

The chief facts of interest in these tables are: First, the extraordinarily large amount of acceleration in the school, amounting to about one-third of the total enrollment; and, secondly, the small number classifiable as "at age" for grade. On the other hand the amount of retardation is about that of schools generally in this section. Ayres† reports 30.7 per cent for the Portland, Oregon, schools and the figures for the Eugene city schools run not far from 30 per cent.

The opportunity is presented here to call attention to certain facts about the problems of acceleration and retardation that have been neglected in most of the past studies but which are made possible by the use of tests of general intelligence. If an age-grade table is prepared using *mental ages* instead of the actual ages as was done in preparing table 11, we find a strikingly different arrangement as is shown in table 14. The number of pupils "at grade" becomes less and the retarded group increases to include almost one-half of the total number (46.2 per cent). This change can be roughly described by the statement that: *The accelerated pupils upon the basis of actual age tend to become retarded upon the basis of mental age, and that the reverse holds for the group considered retarded by the usual standards.* That this conclusion is actually true in individual cases as well as in the mass in shown by tables 15, 16 and 17 where the exact changes resulting from re-classification by mental ages are shown in detail.

At this point it is necessary that certain qualifications be stated in order to avoid implications which are not to be defended here. The re-grouping of pupils for mental ages is not intended to serve as an argument for placing pupils in the grades demanded by the mental ages, nor is it intended to assume that such mental age ratings are exact equivalents in all respects to the normal mentality at the given year, *e. g.*, that a child of twelve testing at 18 years mentally should be placed in grade 12, the normal grade for 18-year-old pupils. The only implication is that since a mental age greater than the actual age in any pupil is an indication of brightness, the accelerated pupils (who are rather generally of superior ability) are really retarded upon the basis of their true ability, and that the reverse is true of retarded pupils (who tend to be of sub-normal ability). Table 18 shows clearly that in every grade the accelerated pupils (who are, of course, actually younger) are older mentally ("brighter") than the normal children, and that this superiority is in turn evident for the normal pupil in comparison with the

TABLE 11

Showing the Age-Grade distribution for the pupils of the three grades of the junior division of the University High School, February 1, 1920.

Age		Grade			Total		
		7	8	9			
12	B	4	4	0	8		
	G	2	2	0	4		
13	B	11	7		18		
	G	8	12	1	21		
14	B	3	5	3	11		
	G	2	8	5	15		
15	B	1	5	6	12		
	G	1	1	6	8		
16	B	0	1	3	4		
	G	3	3	3	9		
17	B	0	1	1	2		
	G	0	1	3	4		
18	B	0	2	0	2		
	G	0	0	0	0		
19	B	0	0	0	0		
	G	1	0	0	1		
20	B	0	0	1	1		
	G	0	0	0	0		
						Totals	%
Total	B	19	25	14	58	120	100.0
	G	17	27	18	62		
Acc.	B	4	11	3	18	40	33.3
	G	2	14	6	22		
Norm.	B	11	5	6	22	44	36.7
	G	8	8	6	22		
Ret.	B	4	9	5	18	36	30.0
	G	7	5	6	18		
% Acc.	B	21.1	44.0	21.5	31.0		
	G	11.8	51.9	33.3	35.5		
% Norm.	B	57.8	20.0	42.8	37.9		
	G	47.0	29.6	33.3	35.5		
% Ret.	B	21.1	36.0	35.7	31.0		
	G	41.2	18.5	33.3	29.0		

retarded one. The conclusion can safely be drawn that, mentally speaking, the accelerated pupils are really to a greater or less degree retarded. This conclusion also finds support in table 5 of the preceding section where it was shown that the pupils of the University High School show a median I. Q. of 107.0 in comparison with the normal 100.0 for unselected children. This means that practically one-half of the 120 pupils of this school reach the level of intelligence of the highest one-quarter of children generally.

The relations between these facts of acceleration and retardation and other portions of the experimental data will be taken up again in connection with the questions of grades, standard educational tests, and the general discussions of later sections.

TABLE 12

Showing the absolute numbers and percentages of acceleration and retardation for the three grades of the junior division. Sexes separate.

	Absolute Numbers	*Percentages*
Accelerated—		
Boys	18	31.0
Girls	22	35.5
Normal—		
Boys	22	37.9
Girls	22	35.5
Retarded—		
Boys	18	31.0
Girls	18	29.0

TABLE 13

Showing the absolute numbers and percentages of accelerated, normal, and retarded pupils for the three grades. Sexes combined.

	Absolute Numbers	*Percentages*
Accelerated	40	33.3
Normal	44	36.7
Retarded	36	30.0
Total	120	100.0

TABLE 14

Showing the absolute numbers and percentages of accelerated, normal, and retarded pupils for the three grades on the basis of *Mental Ages.* Sexes combined.

	Absolute Numbers	*Percentages*
Accelerated	37	31.1
Normal	27	22.7
Retarded	55	46.2
Total	119	100.0

TABLE 15

Showing the distribution of the 36 pupils who are retarded by the usual standards (*i. e.*, upon the basis of actual age) if re-plotted upon the basis of *Mental Age.* Sexes combined. All three grades

	Absolute Numbers	*Percentages*
Accelerated—		
One year	6	
Two years	4	
Three years	1	
Four years	4	
Total	15	41.7
Normal—		
Total	10	27.8
Retarded—		
One year	3	
Two years	6	
Three years	0	
Four years	2	
Total	11	30.5

TABLE 16

Showing the distribution of the 40 pupils who are accelerated by the usual standards (*i. e.*, actual or chronological age) if re-plotted upon the basis of *Mental Age.* Sexes combined. All three grades.

	Absolute Numbers	*Percentages*
Accelerated—		
One year	5	
Two years	0	
Three years	1	
Total	6	15.0
Normal—		
Total	12	30.0
Retarded—		
One year	9	
Two years	8	
Three years	4	
Four years	1	
Total	22	55.0

TABLE 17

Showing the distribution of the 44 pupils who are in the normal grade by the usual standards (*i. e.*, 13 for grade 7, 14 for grade 8, and 15 for grade 9, on the basis of the actual ages) if re-plotted upon the basis of *Mental Ages*. All grades. Sexes combined.

	Absolute Numbers	*Percentages*
Accelerated—		
One year	7	
Two years	3	
Three years	2	
Total	12	27.3
Normal—		
Total	10	22.7
Retarded—		
One year	5	
Two years	10	
Three years	6	
Four years	1	
Total	22	50.0

TABLE 18

Showing the median scores for the tests of general intelligence, both individual and group tests, for the accelerated, normal, and retarded groups of the seventh, eighth, and ninth grades.

	Number Pupils	*Binet-Simon (Stanford)*			*Alpha*	*Chicago*
		C. A.	*M. A.*	*I. Q.*		
Grade 7						
Accelerated	6	11-11	15-1	124.0	82.5	43.0
Normal	19	12-11	14-1	111.0	70.0	36.0
Retarded	10	14- 9	13-1	90.0	54.5	26.5
Grade 8—						
Accelerated	25	13- 0	14-9	115.0	106.0	43.0
Normal	13	14- 0	14-8	101.0	70.0	26.5
Retarded	14	15- 7	13-9	89.5	62.0	29.5
Grade 9—						
Accelerated	9	14- 0	17-0	122.0	137.0	56.0
Normal	12	14-11	16-9	110.5	118.0	55.5
Retarded	11	16- 3	14-3	90.0	93.0	47.5
Grades 7, 8, and 9 Combined—						
Accelerated	40	13- 2	15-2	117.0	104.0	43.0
Normal	44	13- 7	15-0	105.0	85.0	35.5
Retarded	35	15- 9	14-1	90.0	79.0	31.0

SECTION IV.

MEASURES OF SCHOOL ATTAINMENT

For the purposes of portraying pedagogical standing and school progress, two types of measurements are available in addition to age-grade classification. These are teachers' marks and the scores in standard educational tests. Both will be considered in discussing this phase of this investigation.

The average grade of each pupil was determined for the first semester of the present school year, 1919-20. Such an average represents, therefore, the combined estimates of from two to five teachers of the ability of the pupil in as many school subjects. In obtaining such averages no effort was made to correct for inequalities arising from the fact that certain pupils carried five or more subjects. Only the ''core subjects'' were considered, *viz.*, English, history, science, foreign language, and commerce. Subjects reciting less than five times per week were not included.

The list of standard educational tests given to part or all of the pupils follows:

1. Courtis Standard Research Tests in Arithmetic. Series B.
2. Stone Reasoning Tests.
3. Gregory Language Tests (devised by Prof. C. A. Gregory of this University).
4. Ayres Spelling Lists.
5. Ayres Writing Scale.
6. Kansas Silent Reading Test (devised by Dr. F. J. Kelly).
7. Douglass Standard Diagnostic Tests for Elementary Algebra (devised by Prof. H. R. Douglass of this University).

The standard tests were given under the direction of Professor H. R. Douglass by Mr. Peter L. Spencer and others. All were given during the second semester of the school year, chiefly during the month of April, and the exact technique of the authors was used in each case.

Tables 19 to 22 show the average grades earned by the pupils classified in various ways as to grade, sex, age-grade distribution, and intelligence. Tables 23 to 32 give the results in the various standard educational tests according to similar classifications.

Space limits make it imperative that the briefest possible discussion of these results be attempted. Only a few of the outstanding facts will be pointed out.

The grading system in use in the University High School provides for the assignment of seven letter grades as follows:

A+	Very superior work.
A	Superior work (25 per cent, approximately, receive A+ or A).
B+	High average.
B	Low average (50 per cent, approximately, receive B+ or B).
C	Barely passing.
D	Condition (given only during first six weeks of any term).
E	Failure (25 per cent, approximately, receive C. D. and E).

In transmuting these letter grades into numerical scores based upon 100 per cent, the mid-points of the intervals were taken, respectively, as 97.5, 92.5, 87.5, 82.5, 77.5, 72.5, and 70.0. The last is purely arbitrary and is probably in most cases higher than the true grade for failures.

The girls appear to do superior work in all grades. There are no significant differences in the average grades for the different years as often is the case in schools due, perhaps, to a tendency to grade older pupils higher than younger ones. The median grade for the school falls at 82.0. Since the grading system is an approximation to the distribution of the normal curve, the median should theoretically fall close to 85.0. However, in our practice, it is the policy to keep the grades for the initial six weeks of any semester slightly below the norms for the system in use and allow the grades to rise throughout the semester, for psychological reasons, and finally to approximate the true standards for the school. It is evident from this that only the grades of the final six-week period of any semester will approximate very closely to the norms and that averages such as used above will invariably run too low.

Tables 21-22 show how the failures are distributed among the pupils classified, first, as accelerated, at age, or retarded, and secondly, as superior, average, or inferior. Retarded pupils furnish six out of ten failures (61.1 per cent), at age pupils fail once out of four or five times (22.2 per cent), and accelerated pupils furnish about one failure in six (16.7 per cent). It is evident that the greater age of the retarded pupil does not compensate for low ability to an extent that such pupils can maintain average scholarship. It will be remembered that the median grade for the retarded group is 78.0 in comparison with 82.5 for the at age pupils and 83.0 for the accelerated. It should again be pointed out that the retarded group is also younger mentally than the other two groups, the medians being, respectively, 14-1, 15-0, and 15-2. Upon the basis of the I. Q. as superior, normal, and inferior, the first group contributes about one-tenth of the failures (11.2 per cent) and each of the other two contribute equally the balance (44.4 per cent each).

Tables 23 and 24 give the summarized results in the standard educational tests for grades VII and VIII. It will be seen that for both grades the pupils of the University High School score well above the norms in all tests except in the fundamentals of arithmetic as shown by the Courtis tests and in writing. That a somewhat poor showing in writing would prove true is not unexpected since the time allowed for this work during the past year is admittedly too little. Owing to unusual conditions in the school the time allotment for penmanship was reduced to one hour per week in the seventh grade and in the eighth grade only pupils markedly deficient in this respect were required to take penmanship. In view of these unfortunate conditions, the showing is probably as good as can be expected.

With respect to arithmetic ability in the tests of addition, subtraction, multiplication, and division, the reason at first thought was not at all evident. Consultation with the three teachers handling the sections in arithmetic showed that they were unanimous in the belief that the pupils had entered this school from outside schools seriously below normal in their ability to handle these fundamental processes. Realizing that there is always a tendency on the part of teachers to seek to locate the blame in the lower grades of the elementary school, it was decided to test out the matter further by the use of tests which deal with the type of problems more related to the work of the upper two grades. For this purpose the Stone Reasoning Tests were selected upon the hypothesis that since the operations tested by the Courtis tests are supposedly mastered below the seventh grade, the gains registered in these tests in the upper grades are chiefly practice effects and not due to new direct teaching of these processes. But the Stone tests provide a method of throwing into contrast the accuracy of the purely arithmetical operations and the reasoning processes involved in the solution of problems. If then, the former scores should be found to be low as was the case in the Courtis tests, and at the same time, the scores in the reasoning processes should prove to be normal or above, it would seem a justifiable conclusion to believe that the faulty instruction was not that of the seventh and eighth grades but rather that of grades six and below where the fundamental processes are completed as far as direct instruction is concerned. Table 32 presents strong evidence that this assumption is true. The question will be taken up in greater detail in the last section of this paper, which is devoted to general considerations.

It should be pointed out in comparing the results in the standard tests with the norms quoted that most of our scores are April scores and not the June scores upon which the norms are based. This will explain any slight deficiencies of an unfavorable nature and at the same time strengthen any cases of superiority.

The norms quoted for the Gregory Language Tests are tentative but are based upon about one thousand Oregon school children from fifty representative schools.

The list of ten words used for the tests in spelling was taken from column "U" of the Ayres scale and the norms are those accompanying these lists.

For the test materials in writing, the Gettysburg speech of Lincoln was used, beginning "Four score and seven years . . . . .." and ending ". . . . it is altogether fitting and proper that we should do this." The papers were graded by the usual methods by Mr. G. E. Finnerty of this school.

TABLE 19

Showing the grades earned by the pupils of the seventh, eighth and ninth grades during the semester ending February 5, 1920. The figures represent medians in all cases.

Grade	*N*	*Boys*	*Girls*	*Combined*
7	34	80.0	81.0	81.0
8	53	80.0	82.5	82.0
9	32	81.5	83.0	82.0
Entire 3 grades	119	80.0	83.0	82.0

TABLE 20

Showing the medians, averages, and ranges of the grades earned by the pupils of the three grades according to age-grade classification (*i. e.*, accelerated, normal, and retarded) and sex.

	Medians	*Averages*	*Range*	*N*
I. Accelerated Group—				
Boys	82.5	82.4	72-93	19
Girls	84.0	83.3	72-94	22
Both Sexes	83.0	83.0	72-94	41
II. Normal Group—				
Boys	82.5	82.0	72-88	22
Girls	82.5	82.5	65-95	22
Both Sexes	82.5	82.2	65-95	44
III. Retarded Group—				
Boys	77.0	75.1	67-82	18
Girls	79.0	79.2	66-89	17
Both Sexes	78.0	77.2	66-89	35
Groups I, II, and III Combined—				
Boys	80.0	79.9	67-93	59
Girls	83.0	81.8	65-95	61
Both sexes	82.0	80.9	65-95	120

TABLE 21

Showing the distribution of pupils failing or conditioned (*i. e.*, an average semester grade of 74 or below) according to age-grade classification as accelerated, normal, and retarded.

	Accelerated	*Normal*	*Retarded*	*Total*
Number failed or conditioned	3	4	11	18
In percentages	16.7	22.2	61.1	100.0
Number in group	41	44	35	120
Per cent of group failed or conditioned	7.3	9.1	31.4	15.0

TABLE 22

Showing the distribution of pupils failing or conditioned (*i. e.*, an average semester grade of 74 or below) according to the classification as ''Superior'' (I. Q., 111 or above), ''Average'' (I. Q., 90-110), and ''Inferior'' (I. Q., 89 or below).

	''Superior''	*''Average''*	*''Inferior''*	*Total*
Number failed or conditioned	2	8	8	18
In percentages	11.2	44.4	44.4	100.0
Number in group	50	50	20	120
Per cent of group failed or conditioned	4.0	16.0	40.0	15.0

TABLE 23

Showing the median scores in the standard tests given in grade VII in comparison with the published norms.

	Number attempted		*Number correct*		*Score*	
Tests	*Norm*	*U. H. S.*	*Norm*	*U. H. S.*	*Norm*	*U. H. S.*
Courtis:						
Addition	10.5	7.0	6.5	4.0		
Subtraction	11.5	8.0	8.5	7.0		
Multiplication	10.0	6.0	6.5	3.5		
Division	8.5	6.0	7.0	5.0		
Kansas Silent Reading Test					16.2	21.4
Gregory Language Test					23.8*	26.8
Ayres Spelling					73	75
Ayres Writing					57	48

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*GREGORY, C. A.: The Efficiency of Oregon School Children in the Tool Subjects, University of Oregon Publication, 1, No. 1, 1919, p. 50. (Tentative norms based upon 1024 Oregon seventh grade pupils representing 50 schools.)

TABLE 24

Showing the median scores in standard tests given in grade VIII in comparison with the published norms.

Tests	*Number attempted* *Norm*	*U. H. S.*	*Number correct* *Norm*	*U. H. S.*	*Score* *Norm*	*U. H. S.*
Courtis:						
Addition	12.0	9.0	8.0	6.0		
Subtraction	12.5	9.0	10.0	7.0		
Multiplication	11.5	8.0	8.0	6.0		
Division	10.5	7.0	9.0	6.0		
Kansas Silent Reading Test					19.2	25.2
Gregory Language Test					30.7*	36.3
Ayres Spelling					84	93
Ayres Writing					...	54

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*GREGORY, loc. cit., p. 50 (Tentative norms based on tests of 1029 eighth grade Oregon school children from 50 schools).

TABLE 25

Showing the median scores in standard tests for the ninth grade in comparison with the norms.

Test	*Norm*	*Test*
Ayres Spelling	....	100
Ayres Writing	....	64
Douglass Algebra	29.6*	30

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*DOUGLASS, H. R.: A Series of Standardized Diagnostic Tests for the Fundamentals of First Year Algebra. An unpublished thesis submitted to the Graduate School of the University of Missouri, 1920.

TABLE 26

Showing the medians and ranges of scores made in the Kansas Silent Reading Tests for groups of accelerated, at age, and retarded pupils.

	Grade VII		*Grade VIII*	
	Median	*Range*	*Median*	*Range*
Accelerated	20.5	17.8-27.7	29.4	15.4-40.4
At age	21.1	10.5-38.9	32.0	14.9-54.8
Retarded	20.3	17.0-32.9	19.1	5.6-39.8

TABLE 27

Showing the medians and ranges of scores in the Kansas Silent Reading Tests for groups of Superior, Average, and Inferior pupils.

	Grade VII		*Grade VIII*	
	Median	*Range*	*Median*	*Range*
Superior	32.0	18.0-39.0	35.0	17.0-45.0
Normal	20.0	11.0-33.0	22.0	11.0-40.0
Inferior	17.0	13.0-25.0	24.0	10.0-29.0

TABLE 28

Showing the medians and ranges of scores (number worked correctly) for the Courtis Research Tests in Arithmetic by groups of accelerated, at age, and retarded pupils. The scores are the sums of the separate scores in the four fundamental operations:

	Grade VII		*Grade VIII*	
	Median	*Range*	*Median*	*Range*
Accelerated	17.0	4.0-31.0	25.5	17.0-46.0
At age	21.0	10.0-34.0	29.0	11.0-57.0
Retarded	12.0	5.0-23.0	20.5	11.0-50.0

TABLE 29

Showing the medians and the ranges of scores (number problems worked correctly) for the Courtis Research Tests in Arithmetic by groups of Superior, Normal, and Inferior pupils. The scores are the sums of the separate scores in the four fundamental operations.

	Grade VII		*Grade VIII*	
	Median	*Range*	*Median*	*Range*
Superior	20.0	4.0-34.0	29.5	11.0-46.0
Normal	20.0	12.0-27.0	23.0	10.0-57.0
Inferior	12.0	5.0-26.0	20.0	11.0-22.0

TABLE 30

Showing the medians and ranges of scores made in the Gregory Language Tests by groups of pupils classified as accelerated, at age, and retarded.

	Grade VII		*Grade VIII*	
	Median	*Range*	*Median*	*Range*
Accelerated	34.3	23.2-52.6	44.2	18.8-61.4
At age	20.0	5.1-61.8	32.0	14.9-54.9
Retarded	22.1	7.2-46.7	28.2	10.3-46.0

TABLE 31

Showing the medians and ranges of scores made in the Gregory Language Tests by groups of pupils classified as Superior, Normal, and Inferior.

	Grade VII		*Grade VIII*	
	Median	*Range*	*Median*	*Range*
Superior	34.3	19.4-61.8	43.4	14.9-61.4
Normal	32.8	5.1-46.7	31.9	10.3-54.8
Inferior	23.8	12.7-28.8	18.5	7.2-23.6

TABLE 32

Showing the results in the Stone Reasoning Tests in grades seven and eight.

Grade	*No.*	*Total score for class*	*Score per 100 pupils*	*Median score*	*Number problems attempted*	*Number problems right*	*Per cent accuracy.*
VII-A	36	300.9	836	9.1	364	212	58.2
VIII-B	21	177.1	843	9.2	194	128	66.0
VIII-A	17	183.4	1,079	10.8	169	126	74.5

SECTION V.

ANTHROPOMETRIC MEASUREMENTS

Justification for the inclusion of the results of physical measurements may seem necessary in view of the fact that such data has not generally proved to be of the highest value. However, the close relationship between the physical and mental development of the human body cannot well be doubted regardless of whether such parallel maturation is correlated by direct causal factors or whether it represents merely concomitant relationship. For this reason, it can be shown that knowledge of certain physical factors does contribute data which will prove to be of considerable value indirectly in the understanding of individual cases among school children. Physical immaturity, for example, is a frequent factor in low scholarship as can be shown from the experience of any observing teacher.

The measurements selected for use in this study include:

1. Height standing.
2. Weight.
3. Lung Capacity ("Vital Capacity").
4. Strength of Grip.

The weights were all taken without clothing and were recorded in pounds and fractions. Height was likewise read to the nearest tenth of an inch. Both standing and sitting height were obtained although only the results in the first are used here. Lung capacity was measured by means of the wet spirometer and the strength of grip by means of the Smedley combined dynamometer and dynamograph. In using both of the last two instruments three, or in a few cases more, trials were allowed and the one best record preserved. Likewise in the lung and strength measurements the work was done with small groups in mild competition in order to insure a high amount of interest and effort. The dynamometer was held in all of the tests at the side of the leg of the subject without touching the subject. Only the reading for the right hand will be considered here.

The matter of the choice of the norms to be used as a basis for the comparisons presented considerable difficulty due to the fact that the exact conditions under which the various investigators have worked have not been standardized. In the matter of weight, for example, most of the studies have been made with clothing and corrections for this factor are at best but approximate. It was finally decided here that for weight and height the results of Baldwin* were best suited to our purposes, first because of the fact that his weight norms are taken without clothing, and secondly, because his study was primarily made in university high schools or other demonstrational schools which are more likely to resemble the University of Oregon High School than are the results from studies of city school children generally. For vital capacity and strength of grip the norms of Smedley† will be used.

Tables 33 to 34 show the heights and weights of the University High School children in comparison with the Baldwin data. In general it will be seen that the Oregon pupils resemble those of the University of Chicago schools and the Francis W. Parker School very closely. Where our cases are sufficiently numerous to permit of comparisons the deviations in height or weight for either boys or girls are not significant in amount or in a constant direction. The western boys will average somewhat shorter than the eastern pupils and the Oregon girls slightly taller. For weight the Oregon boys show small but definite superiority, but in the case of the girls, this is not true to any extent. It should be pointed out that Baldwin's pupils are physically a superior lot in comparison with school children in general. He states: ". . . . . the children have been under school medical inspection, directed play, and physical education. That these factors are important educational agencies is shown by the fact that, on the average, these children from the Horace Mann School, the University of Chicago Elementary and High School, and the Francis W. Parker School are taller and heavier than any other group of children so far recorded among over a million studied."‡

The differences between the results obtained for vital capacity of the Oregon pupils and the norms of Smedley afford the most striking single fact in the data on physical measurements. Both boys and girls (Table 37) show markedly greater development of lung capacity at all ages. If the vital index as often computed by the formula

$$\text{V. I.}=\frac{\text{lung capacity}}{\text{weight}}$$

is obtained for each pupil, it will be found that the medians for such indices at all ages are higher than norms obtained by dividing the birthday norms of weight and lung capacity furnished by Smedley (see Table 38). It should be remembered that Smedley's data for weight includes clothing and hence these computed indices will run slightly too low. This, of course, will far from explain the marked differences evidenced by the Oregon children.

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*Baldwin, B. T.: Physical Growth and School Progress, Bulletin of the U. S. Bureau of Education, 1914, No. 10, 1-215.

†Smedley, F.: Report of Department of Child Study and Pedagogic Investigations, 46th Annual Report of the Board of Education, Chicago, 1899-1900.

‡loc. cit., p. 9.

In treating data for such small numbers of cases as are concerned in this study, it is very difficult to make reliable comparisons with the published norms because of the influence of extreme variates upon the measures of central tendency. For example, if our 125 pupils are classified according to ages, there will be in no case more than 17 pupils at any age and but one at certain ages. Moreover in certain cases, *e. g.,* for the vital index, which is a fluctuating value for the different ages because of the imperfect parallelism in the increases of lung capacity and weight with age, it is difficult to compare such indices with any of the measures of intelligence like the mental age and the intelligence quotients. Mental age is a score in contrast with the I. Q. which is an index, but on the other hand, the I. Q. is believed to approximate a constant value for an individual year after year. To correlate a somewhat constant index like the I. Q. with a fluctuating index like the vital index is unreliable if the pupils are of different ages. In order to make possible these comparisons of groups of pupils of differing ages, it is suggested that the vital index be compared with a theoretical vital index to be obtained by dividing the lung capacity norm by the weight norm at each age. The result will be a value ranging above or below 1.00 in much the same way as does the I. Q. Such an index might be termed an "index of normality" and could be applied in all cases where values which are statistically indices, in contrast with scores, are concerned. Likewise the index obtained for strength of grip by a similar process:

$$\text{``Index of normality'' for strength of grip} = \frac{\text{Grip (actual)}}{\text{Grip (norm.)}}$$

Tables 37 to 38 show the results of such correlation of these indices with the intelligence quotients. It is to be noted that the relationship between the vital index and intelligence which Smedley, DeBusk*, and others have postulated finds some confirmation in the correlations stated in Table 41. The chief limitations apparent in the use of this method would seem to center about the fact that there must be available reliable norms for any trait under consideration. In such measurements as physical development, there appear to be regional differences which act as disturbing factors in the computations. However, the advantage of increased numbers with a corresponding increase in reliability of the statistical measures found should be considered as an argument in favor of this manner of treatment. At any rate it might prove valuable to try out this plan of correlation with other and larger groups of pupils and for other physical and mental traits where norms are to be had. The sexes need not be separated.

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*DeBusk, B. W.: The Vital Index in Development, Ped. Sem., 24, 1917, pp. 1-18.

Table 40 shows that strength of grip for the right hand shows a correlation of 0.35 for boys and —.08 for girls by the Pearson formula. In the same way the coefficients for the correlation of the I. Q. and the ''index of normality'' for the vital index are 0.244 for girls and 0.240 for boys. The coefficients support the contention of DeBusk and others that there exists a positive relationship between the vital index and mental ability. This relationship is not very perfect and is very probably of indirect nature. It does suggest the interesting possibility of physiological effects upon the mental processes by the efficiency of oxygenation through the medium of the blood stream. The ratio of oxygen intake to the weight of the tissues of the body could conceivably be a factor of influence upon the metabolism of the organism. The most important difficulty in establishing such a relation seems to lie in the fact that the spirometer readings are not exact measures of lung efficiency since different types of breathers and different amounts of effort in using the instrument cause different relations between the tidal, complemental, and supplemental air volumes to arise. There seems to be no method of regulating and standardizing these relations. In theory, these three volumes are summated to form the vital capacity.

Tables 35, 36, and 39 show the comparative development of the pupils of the University High School and about 850-900 pupils of the city schools of Eugene in height, weight, and vital indices. The figures for the Eugene schools were kindly furnished by Superintendent W. R. Rutherford and are published with his permission. The advantages, in the main, are to be credited to the University school, but it should be remembered that the data for the city schools does not extend above the eighth grade. This would tend to cause the comparisons for the upper years to be made between pupils normal to the high school grades in the one case and in the other for over-age pupils of high school age who are still in the elementary schools.

These comparisons are interesting again in that the larger numbers of the city schools dispose of the possibility that the better physical development of the University High School pupils in comparison with Baldwin's and Smedley's norms in a chance effect of the small number of cases.

One possibility which should be called to attention in correlations between mental and physical traits is that such might be due merely to the varying degrees of effort expended by different types of individuals; the more intelligent, perhaps, making greater efforts in the course of taking such measurements as grip and lung capacity and hence introducing a type of spurious correlation.

TABLE 33

Comparing the median heights of the pupils of the University High School with the medians for the pupils of the University of Chicago High School and the Francis W. Parker School (Baldwin).

	Height in inches (medians)			
Boys—				
Age	*Oregon*	*Chicago*	*Difference*	*N*
11½	52.7	55.9	—3.2	2
12½	57.9	57.9	0.0	14
13½	59.0	59.8	—0.8	17
14½	61.6	62.6	—1.0	12
15½	63.3	64.7	—1.4	6
16½	69.5	65.5	+4.0	1
17½	64.5	66.5	—2.0	3
Girls—				
11½	58.5	56.6	+1.9	3
12½	60.0	58.1	+1.9	14
13½	61.1	60.9	+0.2	17
14½	62.2	62.0	+0.2	12
15½	61.9	62.6	—0.7	8
16½	61.8	63.0	—1.2	4
17½	62.3	63.4	—1.1	1

TABLE 34

Comparing the median weights of the pupils of the University of Oregon High School with the medians for the University of Chicago High School and the Francis W. Parker School (Baldwin).

	Weight in pounds (medians)			
Age	*Oregon*	*Chicago*	*Difference*	*N*
Boys—				
11½	68.5	72.7	—4.2	2
12½	87.5	77.8	+9.7	14
13½	89.0	87.0	+2.0	17
14½	100.0	102.5	—2.5	12
15½	109.5	108.5	+1.0	6
16½	144.0	114.5	+29.5	1
17½	129.5	128.5	+1.0	3

Girls—				
11½	95.7	72.5	+23.2	3
12½	80.5	83.0	—2.5	9
13½	99.5	95.0	+4.5	17
14½	103.0	103.5	—0.5	12
15½	109.4	111.2	—1.8	8
16½	123.0	112.5	+10.5	5
17½	120.0	116.5	+3.5	1

TABLE 35

Comparing the heights of the pupils of the University High School with those of the public schools of Eugene according to the measurements furnished by Superintendent W. R. Rutherford of the city schools. Measurements for the city schools are averages, for U. H. S., medians.

	Boys		*Girls*	
Age	*U. H. S.*	*City Schools*	*U. H. S.*	*City Schools*
11½	52.7	54.44	58.5	56.07
12½	57.9	56.16	60.0	56.99
13½	59.0	59.31	61.1	60.35
14½	61.6	61.13	62.2	62.23
15½	63.3	63.73	61.9	62.84
16½	69.5	67.40	61.8	62.63
17½	64.5	....	62.3	....

TABLE 36

Comparing the weights of the two groups of pupils in the same way as in the preceding table of heights.

	Boys		*Girls*	
Age	*U. H. S.*	*City Schools*	*U. H. S.*	*City Schools*
11½	68.5	73.98	95.7	74.31
12½	87.5	79.94	80.5	81.32
13½	89.0	87.16	99.5	97.43
14½	100.0	97.29	103.0	104.00
15½	109.5	114.08	109.4	109.77
16½	144.0	128.07	123.0	115.61
17½	129.5	....	120.0	....

TABLE 37

Comparing the medians for vital capacity for the University of Oregon High School with those of Smedley.

Age	*Vital Capacity in cubic inches*	*Smedley's Data*	*Difference*	*N*
Boys—				
11½	120.5	110.2	+10.3	2
12½	151.0	119.6	+31.4	13
13½	164.0	137.7	+26.3	16
14½	170.5	154.5	+16.0	12
15½	241.0	174.5	+76.5	5
16½	237.0	206.2	+30.8	2
17½	209.0	218.8	— 9.8	1
Girls—				
11½	138.0	97.1	+40.9	3
12½	150.0	105.9	+44.1	9
13½	164.0	116.9	+47.1	17
14½	152.0	128.8	+23.2	12
15½	160.0	135.7	+24.3	8
16½	197.0	140.6	+56.4	5
17½	196.0	142.9	+53.1	1

TABLE 38

Comparing the vital indices of the University High School pupils with those computed from the birthday norms of Smedley. Parentheses show numbers measured.

	Boys		*Girls*	
Age	*Oregon*	*Smedley*	*Oregon*	*Smedley*
11½	1.75 (2)	1.53	1.44 (3)	1.36
12½	1.90 (13)	1.52	1.87 (9)	1.32
13½	1.90 (16)	1.54	1.65 (17)	1.28
14½	1.73 (12)	1.56	1.48 (12)	1.24
15½	2.01 (5)	1.55	1.46 (8)	1.25
16½	1.76 (2)	1.69	1.60 (4)	1.23
17½	1.54 (1)	1.67	1.63 (1)	1.22

TABLE 39

Comparing the vital indices for the pupils of the University High School with data obtained for the city schools of Eugene by Superintendent W. R. Rutherford. Data for Eugene schools computed as averages, for the U. H. S., medians. For numbers of cases see preceding table. Numbers for city schools about 800.

Age	*U. H. S.*	*City Schools*	*U. H. S.*	*City Schools*
11½	1.75	1.554	1.44	1.386
12½	1.90	1.553	1.87	1.382
13½	1.90	1.542	1.65	1.339
14½	1.73	1.590	1.48	1.377
15½	2.01	1.517	1.46	1.366
16½	1.76	1.676	1.60	1.367

TABLE 40

Showing the Pearson coefficient of correlation between the I. Q.'s and the "indices of normality" for strength of grip in the right hand (upon the basis of Smedley's data).

	r	*P. E.*	*N*
Boys	+0.350	.078	57
Girls	—0.080	.087	60

TABLE 41

Showing the Pearson coefficient of correlation between the I. Q.'s and the indices of "normality" for the vital indices computed from the data of Smedley.

	r	*P. E.*	*N*
Boys	+0.240	.089	51
Girls	+0.244	.089	51

TABLE 42

Showing the medians for strength of grip in the right hand for boys and girls compared with the norms of Smedley. Measurements in kilograms.

	Boys		*Girls*	
Age	*Oregon*	*Smedley*	*Oregon*	*Smedley*
11½	24.25	20.03	19.00	17.65
12½	27.50	22.45	23.00	20.19
13½	30.00	26.43	25.00	23.49
14½	33.00	30.40	25.50	26.10
15½	38.00	36.38	26.00	27.91
16½	44.50	42.35	28.25	29.50
17½	47.50	47.14	36.00	29.63

SECTION VI.

CORRELATIONS, DISCUSSION AND CONCLUSIONS

In this concluding section the effort will be made to correlate the data presented before and make certain applications of our findings to school problems and at the same time suggest other problems which may be attacked by these methods. It is not believed that the problems to be discussed here can be answered in any degree of finality, but it is thought that solutions may be suggested.

At the outset it may be of value to raise the entire question of intelligence testing and other forms of educational measurements as well. In spite of the wide-spread use of such objective methods as those of the tests of native ability, it may fairly be said that among the rank and file of public school men and women there are still those who raise certain questions. They often hold to the view that careful and experienced teachers are just as accurate in their estimates of intelligence as tests can be made to be, or again, they ask: Even after one has found the mental age, the I. Q., or the score in Army Alpha, of what value is this knowledge? Are not such measures prohibitive in their demands upon time and energy?

The last will be taken up first since it can be answered quite briefly. To take a concrete illustration, a pupil spends in a given grade in the course of a full year's work of nine months something more than a thousand hours under the direct observation of the teacher, granting a six-hour day. It requires approximately one hour of these one thousand to give an individual Binet examination —or one-tenth of one per cent of the school year. If there are thirty pupils in a room and a group scale requiring an hour's time to give is used, the time expenditure is about two minutes per pupil plus about five minutes per pupil to score the results. If the results of such tests of intelligence have even the smallest practical value, the time expenditure is almost negligible. Every year we devote dozens of times this amount of time to one or another worthy cause which may be very much less closely related to school affairs. Passing from this question to that of the possibility of intelligence tests being entirely superfluous since capable teachers of long experience can estimate ability with a reliability which approaches that of the tests, it should be recalled that it is true that the teachers of the University High School were able to estimate intelligence with a reliability of from .60 to .70 or more as shown by the coefficients of correlation. In view of the extremely favorable circumstances under which these ratings were made, it is doubtful whether much greater accuracy can be ordinarily obtained. If, then, we examine a few of the cases of displacement we will find ourselves forced to the conclusion that, although the reliability of the method of estimation is high in the mass, in individual cases it will lead to serious error. Stated in other words the method breaks down in just those individual cases where it could prove of the greatest value. To cite some illustrative cases, the following will serve the purpose:

Case 1.—V. L., girl. C. A., 11-8. M. A., 15-5. I. Q., 132. Army Alpha, 83. Chicago, 49½. Average grade, 79. Teachers' estimate, 4.25 (pooled estimates of four teachers; range of estimates 2.0-6.0. See preceding section for basis of assigning ranks).

This is a case of a quiet, retiring pupil, physically immature, somewhat irregular in attendance, and handicapped by ill health to some extent. Previous school advantages probably not of the best. The teachers have evidently judged her ability by her grades overlooking the above factors and the additional one that she is almost two years ahead of her grade and is thus subjected to extreme competition. Her real ability demands that she be rated 1.0 or a fraction more in the scale used for estimation.

Case 2.—R. F., boy. C. A., 12-7. M. A., 16-7. I. Q., 132. Alpha, 133. Chicago, 47½. Average grade 73 (failure). Teachers' estimate 3.0 (pooled results for four teachers; range 1.0 to 6.0).

Pupil vivacious, troublesome in minor ways, noisy, lazy, inattentive, self-satisfied, and more or less indifferent to praise or criticism. Could do the highest type of school work if he so desired. Father an able professional man. Another case of teachers basing judgments upon school work. Pupil accelerated two years but bids fair to lose this position unless some method of interesting him in school work is found. Should be rated 1.0.

Case 3.—C. W., girl. C. A., 13-10. M. A., 12-9. I. Q., 92. Alpha, 69. Chicago, 27½. Teachers' estimate 3.25 (pooled results for four teachers; range 2.0-6.0). Average grade 87.

Pupil active, vivacious, energetic, works carefully and consistently, takes prominent part in school activities, a natural leader among her class-mates, and would be popularly described as "looking intelligent." Her pleasant manners and excellent work habits cause her to be rated 3.25 when her real ability is 5.0 or 6.0 on our scale. She is just at grade for her age.

Case 4.—M. G., boy. C. A., 15-9. M. A., 18-1. I. Q., 115. Alpha, 130. Chicago, 64. Average grade 73 (failure). Teachers' estimate 6.0 (pooled results of five teachers; range 4-9).

One of the notoriously lazy boys of the school. Constant minor offender against school rules. Not responsive to social pressure. Prefers to read wild west stories to school books. Could easily do 90 per cent school work. Rated too low because of work habits. Should be rated 2.0-3.0. Is retarded about one year. Has failed before.

If space permitted many other cases could be cited, *e. g.*, the girl standing fourth in the entire school upon the basis of the I. Q. and beyond doubt to be rated at 1.0 on our scale was assigned the rank 6.0 by her teachers, the estimates ranging from 4.0-8.0. It will be argued that these are the exceptions and not the rule. This is just the point in the position taken here. It is in the exceptional case that the intelligence examination proves its worth. We have shown by table 10 of Section II that 18.9 per cent of the pupils are displaced more than two groups—an amount which as was shown is a serious displacement—and that but one pupil in six can be located in the correct group as determined by the tests. Sixty-one and one-tenth per cent are located with a displacement of no more than one group—an amount which is not serious. This leaves one pupil in five who cannot be rated by the method of estimation because of complicating factors and it is just this pupil that most needs to be given an evaluation in terms of native ability. For these reasons it does not seem likely that the method of estimates promises any serious rivalry to the method of tests. Two other points suggest themselves as being worthy of brief mention. The first is that the method of estimates is almost as expensive in time and efforts as are individual tests and much more so than group examinations, as was shown by the fact that in order to obtain the high reliability of our estimates, some teachers devoted as much as five hours to the task. The second point is that both methods are of practical as well as instructive value since they are mutually corroborative. The fact that comparisons of the ratings obtained by the two methods show discrepancies leads to deeper analysis of pupil's abilities by teachers and a truer understanding of the complex relationships between the many factors combining to determine school attainment.

The remaining point as to what are the schoolroom applications of the mental age, I. Q., or other intelligence ratings will not be further discussed here but taken up incidentally along with the other problems in the pages to follow.

The next application of the method of objective measurements in school practice is that of the possibility of using standard educational tests and intelligence scores as a basis for promotions, grading, and school advancement. This is a new field where generalizations are dangerous but offering such possibilities that a few ideas merit some consideration. In Section IV it was shown that the pupil who is considered as accelerated by the usual standards would in most cases be classified as retarded in an age-grade table based upon the use of mental ages. This fact has been repeatedly emphasized by Terman and others and apparently passes unchallenged. Could, then, a pupil do the work in the grade which is normal for his mental age in a satisfactory manner and prove able to stand the competition of pupils actually one or more years older? Obviously to transplant the twelve-year-old boy or girl testing at a mental age of fifteen (I. Q. approximately 125) into the first year of the high school without completing the work of grades seven and eight would be an entirely unwarranted educational policy which might entail no end of objectionable consequences. This hiatus in the fundamentals of subject matter would persist throughout the school and real life of the pupil and worse still the foundations for future building would be undermined. Such practices are not to be seriously considered. But, on the other hand, there may be an alternative. As every teacher knows we have with us in the classroom a considerable group of pupils of superior ability who appear to be bored with the work of the school and grade and who in the end fall either into attitudes of apathy or petty mischief. It has been a rather frequent criticism of the schools of democracies that they look first to the average or sub-average child often to the neglect of real ability. This may explain in large part the fact that so many men of genius have been overlooked by their teachers only to burst forth like meteors in their later lives. There is little doubt that the lock-step method of school progress has tended to divert superior ability and energy, particularly in boys, into wasteful and negative channels. These criticisms are not intended to serve as arguments for falling into the errors of some of the European school systems of focusing the entire effort and attention of the schools upon the few of superior endowments at the expense of the many. One extreme is as bad as the other, except that the latter does seem to produce a certain body of social, political, and scientific leaders. The real issue is that any system which discriminates between the various levels of ability is wasteful and unfair. Just what the mechanics of a system permitting pupils to progress at rates determined by their individual abilities will prove to be is not within the scope of this discussion to suggest. Several efforts have been made in the past in the form of the Pueblo plan, modified monitorial systems, the abolition of class instruction with a return to individual teaching, the Batavia scheme, and many others. Each of these has advantages and none are free from objections. Divergent as they are, they are in agreement on the one point that the present lock-step system is undesirable in view of the new knowledge of the magnitude of individual differences.

Under present conditions we find in extreme cases where the pupils are too mature to derive full value from a grade that we are forced to promote these ahead a half grade or a grade without the intervening work. That such promotions are make-shifts would not be denied. However, if under the present conditions forced promotions are necessary at times in individual cases or for administrative reasons, we should supplement our judgments in these promotions with whatever other types of data are at hand. That the results of intelligence and standard educational tests can be made to serve this purpose is well illustrated by the following case reported by the writer in Educational Administration and Supervision for February, 1920.* Here because of crowded conditions and unequal distributions of pupils it was found necessary to promote about ten pupils from the seventh B to seventh A section. It was the plan to select about that number from the lower grade upon the basis of ability, choosing the highest in the class. Teacher's estimates and judgments were unavailable since the pupils were all new to the school and had come from at least a half-dozen different schools, in some cases outside the state. It was finally decided to base the promotions upon the showing made in a "battery" of educational tests consisting of the Courtis, Kelly and Gregory tests. If time had permitted the Binet tests would have been given. Unfortunately these had to be deferred until later; the results are, however, included in the table below, which is reproduced from the original paper. The pupils standing highest in the three tests were advanced into the next section except for two rejections, one for physical immaturity and the other on account of parental objection.

TABLE 43

Records of seven pupils who were advanced from 7B to 7A.

	Individual Tests			*Average Group Tests*		
Pupil	*C. A.*	*M. A.*	*I. Q.*	*Grades*	*Chicago*	*Alpha*
A. H.	13-3	15-9	119	85	54	98
J. K.	12-9	14-9	114	80	36	114
H. C.	14-2	13-0	93	76	15	65
J. B.	12-4	14-0	114	82	45½	109
K. E.	12-9	14-11	117	82	34	102
B. B.	11-8	13-3	113	85	38	97
E. T.	12-2	15-9	130	83	45	94
Averages	12-8.7	15-5.6	114.3	81.9	38.2	97.0
Medians	12-9.0	14-7.0	114.0	82.0	38.0	98.0

Records of pupils regularly belonging in grade 7A—

	C. A.	*M. A.*	*I. Q.*	*Grades*	*Chicago*	*Alpha*
Averages	13-5.6	14-6.0	108.0	81.4	35.1	87.5
Medians	13-3.0	14-6.5	107.0	81.5	36.5	79.0

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*Ruch, G. M.: An Experiment with Forced Promotions, Educational Administration and Supervision, 6, 1920, pp. 71-73.

"Examination of the figures given above leads to the conclution that the promotions could be defended except in the case of H. C. who did passing work, average grade of 76 (passing 75) although at a high expenditure of effort. In no other case did a pupil fall below the median grade of the school (median for school 82; boys, 80, girls 83). The one pupil doing poor work would have been eliminated on the basis of the supplementary evidence furnished by the intelligence tests had these been possible at the same time that the pedagogical tests were made."

This illustration, even in spite of the small number of cases involved, tempts one to conclude that the careful use of the results of a combination of mental, educational, and physical tests would offer a basis for forced or special promotions, where necessary, which is about as reliable as educational practice can be made empirically. In the foregoing example, much valuable supplementary data is again overlooked in the direction of physical factors. To take a single case, that of the pupil not advanced because of physical factors, we have the following:

Pupil—H. M., Boy—			*Attempts*	*Right*	*Score*
C. A.	11-11	Courtis			
M. A.	14-0	Addition	8	8	
I. Q.	117	Subtraction	12	12	
Alpha	83	Multiplication	5	5	
Chicago	38	Division	6	6	
Average Grade	83				
Weight	72	Kelly			17.8
Height	52.5				
Vital Capacity	130	Gregory			52.6
Vital Index	1.80				
Grip—Right	27				
Grip—Left	29				

Examination of this data shows that the pupil rates quite satisfactorily in all of the tests of general intelligence, fairly high or very high in the standard educational tests, but that there is some evidence of physical immaturity, particularly in height. This is not serious in relation to the norms for eastern children, but is somewhat subnormal for the pupils of this school. Taking into account the fact of the low age of the pupil as well, it was decided not to permit him to make the advance in grade. Another case which shows the influence of physical factors is that of a boy who is one year accelerated but who has failed to maintain the high standards of work evidenced by accelerated pupils. His measurements follow:

S. F.—Boy.

C. A.	12-10	Courtis	*Attempts*	*Rights*	*Score*
M. A.	11-8	Addition	6	2	
I. Q.	91	Subtraction	6	6	
Alpha	54	Multiplication	8	5	
Chicago	36½	Division	7	6	
Average Grade	75				
Weight	63	Kelly			22.3
Height	56				
Vital Capacity		Gregory			18.8
Vital Index		Ayres Spelling			80.0
Grip—Right	22.5	Ayres Writing			40.0
Grip—Left	22.0	Stone Reasoning	9	6	10.5

This boy is somewhat sub-normal in intelligence although not seriously enough to explain his poor school work. His previous school advantages have not been of the best but this also is not a serious defect. The real reason for his poor school work is to be found prominently involving the fact that his mentality will not warrant his continuance in a grade one year above the normal for his age and further that his physical development is retarded. The boy is almost the typical picture of the cases of mal-nutrition as described in works on school hygiene. It is not accurate to speak of him as handicapped by ill health as he is rarely sick and is regular in attendance at school, but, casual inspection reveals that metabolism is carried on at a very low ebb as is evidenced by his apathetic manner. In all probability he will soon lose his advantage in school position and through failure drop back into his proper grade. It seems to be one of those cases where a teacher can conscientiously advise the parents to allow the boy to be retained for one and a half or two years in grade eight before allowing him to enter high school. It is even possible that parents would be glad to pursue this plan if presented as outlined here with the facts before them and in a sympathetic manner, with some reservations, of course, in the matter of revealing intelligence scores.

These case descriptions suggest at once the problems of age-grade distribution as a measure of school progress as dependent upon factors of native endowment. Acceleration in most schools in the past has not attracted a great deal of attention, due to the fact that our methods of promotion did not favor the production of acceleration to any such degree as they did produce conditions of retardation. It has been shown, as might have been expected, that acceleration is closely related to superior ability. Our figures presented before point unmistakably to this conclusion. That the reverse would hold true of retardation has not been nearly so well accepted because of the multiplicity of factors involved in causing pupils to fall behind grade. However, there is a growing suspicion that many of the conventional causes to which retardation has been attributed are after all the superficial causes which often conceal the real reasons. For this reason it was thought worth while to attempt to analyze our cases of retardation in the light of the experimental facts gathered. One of the striking facts is that of the relative ranks of the accelerated, at age, and retarded groups in the various types of tests. In general the most perfect gradations are found to be characteristic of the tests of general intelligence (see table 18), school marks (see table 20), and percentages of failures (tables 21 and 22) and is least characteristic of the standard educational tests and the physical measurements (tables 26, 28, and 30). In order to make certain of these comparisons directly portions of the foregoing tables are reproduced here.

TABLE 44

Showing in summarized form the results of the tests of intelligence and school marks for the groups of accelerated, at age, and retarded pupils of the entire school. All medians.

	N.	*C. A.*	*M. A.*	*I. Q.*	*Alpha*	*Chicago*	*Grades*	*Per cent failing*
Accelerated	40	13-2	15-2	117	104	43	83	7.3
Normal	44	13-7	15-0	105	85	35.5	82.5	9.1
Retarded	35	15-9	14-1	90	79	31	78	31.4

TABLE 45

	Grade VII			*Grade VIII*		
Test	*Accelerated*	*At age*	*Retarded*	*Accelerated*	*At age*	*Retarded*
Kelly	20.5	21.1	20.3	29.4	32.0	19.1
Courtis (totals)	17.0	21.0	12.0	25.5	29.0	20.5
Gregory	34.3	20.0	22.1	44.2	32.0	28.2
Ayres Writing	40.0	40.3	55.0	45.0	65.0	55.0
Ayres Spelling	60.0	81.7	75.0	96.0	92.5	86.7

In examining the foregoing summaries one cannot fail but be impressed with the weight of native ability in the determination of school standing. One thing is certain, *viz.*, that mental deficiency is a far more powerful factor in the cause of retardation than has been commonly supposed notwithstanding several authorities to the contrary who asserted that this is a minor if not negligible influence. Concretely to the point is the matter of late entrance. Why should delayed entrance to the public schools result in a lessened acquisition of classroom knowledge, all other things being equal, in comparison with the pupil who begins his school life on schedule time? He must have traveled the same road through the school, studied under the same instructors, followed the same course of study, etc. It must be true that such groups of late entrants within the ranks of the retarded cannot account for the generally poor showing of the latter. In the case of ill health, moving away, and similar causes, our contentions are not meant to apply. These are admittedly real causes for pupils falling behind grade. However, as we shall show below, there is a strong tendency in the case of loss of time through changing schools, for the factor of intelligence to enter once more. The floating population represents a class very largely recruited from the ranks of those who are to be described as economic failures to a greater or less degree. Here, even though such frequent changes are real handicaps to successful school work, the underlying cause reduces often to the inability of such homes to maintain a satisfactory standing in the economic competition of the industrial world. The economic instability is but the superficial cause. In order to check upon the weight to be assigned to the factor of native ability in individual cases of retardation as well as in the mass as shown by the tables of medians above, the full school history of all the cases of retardation remaining in the school was obtained. Of the thirty-five cases of retardation in the school during the first semester of the school year 1919-1920, thirty-one of these pupils continued throughout the year. In order to examine the attributed causes for these pupils having fallen behind grade, the detailed school history of each case was secured by the combined use of information blanks, personal interviews, and conferences with parents. The school progress of each pupil was then charted out from the time the pupil entered the first grade to the present time. That a few errors inevitably have crept in matters very little since only the attributed causes are to be considered and these are purposely to be taken at face value. It is not believed that the attributed causes are generally the true causes, on the other hand, it was quite often evident that the contrary was true. The real intention is to subject the traditional attributed causes to a further analysis in the effort to show that such causes are but superficially operative and that in many cases deeper-seated forces have operated to cause the pupil to make slow progress through the schools. Table 46 shows in a summarized form the inter-relations between the attributed causes and such factors as the intelligence quotients and the number of schools attended. Notwithstanding many exceptions, the number of schools attended should in the mass prove to be a rough measure of the economic instability and restlessness of the home from which the pupils have come. That some relation between the factor of intelligence and the floating home exists has been pointed out by numerous investigators.

TABLE 46

Giving the median I. Q.'s, absolute numbers, percentages, and numbers of schools attended for the groups as classified upon the basis of attributed causes for the 35 retarded pupils.

Attributed Cause	*N.*	*Per cent*	*Median I. Q.*	*Aver. No. of schools attended.*
I. Single Causes:				
Absence due to changing schools or being put back	6	19.3	89.0	6.17
Absence due to ill health or accidents	3	9.7	90.0	3.67
Service in army	1	3.2	101.0	3.00
Late entrance	4	12.9	100.5	3.25
Inability to learn	5	16.1	86.0	4.40
Lack of application	7	22.6	90.0	4.00
II. Multiple Causes:				
Absence due to changing schools and ill health combined	1	3.2	90.0	6.00
Ill health and lack of application combined	2	6.5	99.5	5.00
Late entrance and poor health combined	2	6.5	74.5	4.50
III. Left School Before Data Was Secured:				
Transferred to another school	1		62.0	...
To go to work	2		80.0	...
Moved away	1		...	...
	35			

Examination of the foregoing table shows the suggestive fact that no matter what the attributed cause of retardation may be, that the median intelligence of no group rises above mediocrity and in the vast majority of the classes it falls decidedly below the normal. The highest levels of intelligence accompany such factors as late entrance, army service delays, and ill health coupled with other causes. It is quite evident that none of these groups would logically be expected, *per se,* to be characterized by low grade ability in the same sense that lack of application or inability to learn would be. This data, although slight in amount, would tempt one to adopt a conclusion that is diametrically opposed to the statement made by some students of retardation that defective mentality is a slight factor in slow progress through the schools. Rather would poor native endowment appear to underlie most of the traditional causes for these conditions. Terman* quotes Dr. Gulick as taking the position "that relatively few children are so defective as to prevent success in school or life," but accepts the results of Dickson whose findings are quite in accord with the facts presented above. One thing seems to be certain, at any rate, and that is that the whole subject of the causes of retardation must shortly be re-opened in the light of the new knowledge in the field of individual differences and tests of endowment.

This relation between school progress as rated in terms of acceleration and retardation and the factor of native ability or general intelligence suggests the problem of comparing the scores made in the standard educational tests with ability by the method of correlation. The exact degree of relation between school acquisition and real ability has been a much disputed question in the past, and only recently has much experimental evidence been available for purposes of discussion of such points. In table 47 presented below are given the Pearson coefficients between the I. Q. and the scores in the pedagogical tests, grade by grade. A few statements concerning the method of handling the data for these correlations are needed. The method of averaging the coefficients for the three grades (in part of the cases, two grades) was that of a "weighted" average in which the exact size of N was allowed to influence the average. This is obviously a truer measure than a direct average of the two or three coefficients. It may be objected that even such averages are not very reliable. This is admitted but, on the other hand, it is thought that such weighted averages are in most cases lower than the true correlations. For example, the correlation for all pupils of all three grades between the I. Q. and the average grades earned is 0.533 plus or minus .044 but the weighted average correlation is 0.480. The use of the weighted averages of the coefficients makes it possible to avoid certain errors which would arise in comparing scores in a given test for several different grades, *viz.*, the I. Q. varies about 100 in each grade while the test scores vary about different bases in each grade, usually a series of increasing values as we pass from a grade to the next higher, etc. This fault, of course, does not apply in the case of the average grades since the grading system has a constant base at all grades. Since the I. Q. is an index and not a score, it could only be used for correlations within a grade for comparison with scores but might be used for all grades for comparisons with other indices (the school marks are obviously indices). The mental age, in contrast, is a true score and might be used but it is open to the objection that the same mental age score might stand for pupils representing all three grades and hence introduce an error by virtue of the fact of unequal training effects in the different grades. This effect would most likely be most serious in subjects receiving direct training in the grades under discussion, *e. g.*, language, and least serious in those subjects where the direct training has ceased several grades below the ones here concerned, *e. g.*, in the Courtis tests. These considerations form the argument for the use of the weighted averages of the Pearson coefficients.

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*Intelligence of School Children, p. 119.

In the Stone tests only the reasoning scores are concerned. In the Courtis tests the scores for the four operations are combined. This is a purely arbitrary procedure, but since a point gained in addition is not so very unequal to one for subtraction or multiplication, the errors may tend to balance one another to a large extent. At any rate, for our purposes, it was desirable to have a single value to stand for the ability in the fundamentals of arithmetic processes.

Table 48 shows the weighted average correlations arranged in order of magnitude.

TABLE 47

Showing the Pearson coefficients of correlation for the intelligence quotients and the scores made in the standard educational tests by grades.

	Grade VII		*Grade VIII*		*Grade IX*	
Name of Test	*r*	*P. E.*	*r*	*P. E.*	*r*	*P. E.*
Stone (Reasoning)	0.715	.055	0.590	.066		
Gregory	0.559	.082	0.661	.057		
Average Grades	0.396	.099	0.535	0.65	0.471	.093
Courtis (Sums)	0.342	.103	0.306	.087		
Kansas S. R.	0.298	.109	0.702	.052		
Ayres Spelling	0.080	.116	0.263	.094	0.298	.114
Ayres Writing	—0.350	.102	—0.034	.101	—0.159	.120
Douglass Algebra					0.397	.481

TABLE 48

Showing the weighted averages of the coefficients for the I. Q. and the various tests arranged in order of magnitude.

Test	*Weighted Average Coefficient*
Stone Reasoning scores	0.65
Gregory Language Test	0.62
Kansas Silent Reading	0.53
Average Grades	0.48
Courtis (Sums)	0.32
Ayres Spelling	0.22
Ayres Writing	—0.17

The correlation between the grades earned and the mental age ratings is 0.42, P. E., 0.76, which is slightly below the coefficient which Proctor reports for the 111 ninth grade pupils which he studied (r equals 0.45). The number of cases used for our correlation was 117.

If the pupils of the school are classified upon the basis of the I Q. as before, into groups of superior, average and inferior, the correlations with the mental age for school marks are:

Group	*N.*	*r*	*Median M. A.*	*Median Grade*
Superior	50	0.23	16-3	84.1
Average	48	0.29	14-4	80.4
Inferior	18	0.18	11-11	77.5

It seems to be true that pupils who are to be classified as of average ability are somewhat more likely to realize results in school work according to their ability than are either very able or very dull pupils. The medians for mental age and marks are quite uniformly graded among the three groups and suggests that such data can throw considerable light upon a problem which is of prime importance in school practice, *viz.*, the realization of the maximum efforts of each pupil and of the establishment of just standards of attainment.

With the use of a grading system like the one in use in the University High School where the assignment of school marks must follow approximately the distribution of the normal curve, it is possible to equalize the distribution of grades and to attain a standard which is *relatively* just, *i. e.*, the pupils can be graded with respect to each other. This plan has generally proved more workable than attempts at grading upon any absolute basis. The relative grading plan does, however, require that the standards be "set" according to the abilities of the group of pupils in such a way as not to be unfair to any particular unit of the pupils, *e. g.*, to discriminate against the dull group, or to prevent differentiation at the upper levels in advent of low standards.

In order to attempt to evaluate the standards used for grading in the University High School, the actual distribution of the assigned grades will be compared with the best-fitting normal curve for this actual distribution. The table below shows the actual number of each letter grade given, the theoretical number assigned to the best-fitting curve, and the approximate numbers for the normal curve. In using the letter grades, the mid-points were taken as before as 97.5, 92.5, 87.5, etc.

TABLE 49

Letter Grade	*Theoretical numbers*	*Approximate theoretical numbers*	*Actual numbers*
A+	1.56	2	1
A	9.73	10	4
B+	29.55	30	30
B	43.75	44	51
C	31.40	31	24
D	11.05	11	13
E	1.89	2	6

Average, 82.29.
Sigma, 5.89.
N=129.

It will be noted from these figures that the actual distribution of grades is skewed slightly from the normal toward the lower end of the scale. This is in part due to the fact that the average grades are somewhat lower than the true grades as explained in a preceding section, and partly due to the super-normal numbers of very low grade pupils in the school (see tables of distributions for the intelligence quotients). On the other hand, the very large numbers of exceptionally high grade pupils which have been described as characteristic of this school, fail to reveal their presence in the upper ranges of the grading scale. The skewness of the curve would seem to mean either one or both of two alternatives:

1. That the standards are uniformly too severe in this school, or
2. That the high grade pupils are not doing their maximum quality of work.

There is some evidence to be had for both views. In the first place, 13 C and 6 D grades were given—a total of 19, whereas the theoretical indicates but 13 failures (D's and E's). The numbers of failures is therefore somewhat excessive. On the other hand, but five pupils receive A or above when 12 should score that much according to the normal distribution figures. This, in view of the marked skewness of the curve of the distribution of the I. Q.'s at the upper ranges, would indicate that the work of the most intelligent pupils does not approach the maximum attainment to as perfect a degree as for other groups. The truth of this conclusion again must be tempered in the light of the fact that children of superior ability tend to be accelerated and are thus subjected to greater competition than normal children. All in all, the evidence does not seem to point to the existence of any considerable injustice to any group arising from the standards of scholarship in the school, but it does show that with more attention to the assignment of grades there could be maintained a somewhat closer approximation to the theoretical curve, particularly in the extreme ranges.

As to the possibility that the most able pupils do not realize as fully their highest possible attainment as do the normal and inferior groups, the evidence follows:

TABLE 50

Giving the median scores for the Superior (I. Q.'s 111 or above), Average (I. Q.'s 90-110), and Inferior (I. Q.'s 89 or less) groups for all grades. Sexes combined.

Group	*No.*	*C. A.*	*M. A.*	*I. Q.*	*Alpha*	*Chicago*	*Average Grades*
Superior	50	13-1	16-2	121.0	108.0	45.0	83.0
Average	50	14-4	14-3	101.0	81.0	36.0	81.0
Inferior	20	15-8	11-10	84.5	65.0	25.5	77.0

It will be noted that although the average pupil earns grades four points above the inferior, the superior pupil earns but two points more than the average. In practically all of the scores except the grades the medians for the superior group are higher by a larger margin from the average than the latter are in turn from the inferior, but at the same time it must be remembered that the superior pupils are actually younger than the others and are likely to be accelerated and hence subjected to more intense competition. The evidence is therefore not very conclusive.

In conclusion it should be pointed out that many other lines of investigation, conclusions, applications, and the like, have been suggested which, for reasons of the limitations of space, must be neglected. Specifically there are certain questions involving the diagnostic values of tests of intelligence or of pedagogical accomplishment which are deserving of attention. One such case was pointed out in passing in the matter of the discovery of the reasons for the poor showing of the three arithmetic sections in the fundamentals of arithmetic. Here it was possible to check up the testimony of the teachers concerned, with the more objective measures of experimental education. That the teachers were agreed upon the position that the fault was to be traced to poor instruction in the lower grades of the elementary school suggested the plan of checking the abilities in the four fundamental processes as measured by the Courtis tests against the more intellectual processes of reasoning and inference brought into play in the tests devised by Stone. In case of the latter, as well as in the former, the accuracy scores revealed again the early weakness of formal instruction in this subject, but at the same time, indicated a tendency toward improvement under the force of later instruction and also that there was no sub-normal accomplishment in the types of problems characteristic of the higher parts of the elementary school curriculum. Actual tracing back of the difficulty through the lower grades in consultation with the Superintendent of the Eugene Schools revealed corroborative evidence that these pupils had received the major portion of their instruction in the fundamentals of arithmetic at the hands of an unskilled teacher who was later dismissed from the system. This evidence establishes almost beyond doubt the correctness of the inferences drawn from examination and comparison of the scores from the two standard arithmetic tests.

Other questions of the diagnostic values of the various types of tests might well be considered if space were available, since there is every indication that this phase of school measurement is but beginning to attract the attention of workers in the elementary field. Diagnosis will in all probability be a prime characteristic of the newer tests and the newer methods of experimental education. If any new light has been shed upon the application of experimental methods in the course of this survey of a single school, the efforts expended are well repaid.

SUMMARY

Briefly stated the main conclusions presented in this discussion are:

1. In view of the value of the results of intelligence testing from the administrative angle, the amount of time required for tests cannot reasonably be held to be prohibitive.

2. Group tests will not ordinarily be found satisfactory for individual diagnosis, but will usually suffice for the purposes of mass measurements.

3. Teachers' estimates of intelligence are not likely to prove substitutes for individual testing, even if the reliability of such estimates might be very high, because the data on those pupils misjudged by their teachers is the very data which are most needed.

4. The pupils of the University High School were found to be a composite group composed of two distinct elements; first, pupils from University faculty homes and other homes of professional people, and secondly, pupils representative of homes of low economic level. These factors must necessarily be reckoned with in the interpretation of certain of the findings.

5. Group test ''Army Alpha'' was found to have a somewhat greater reliability than the ''Chicago Group Intelligence Test'' in comparison with the Binet tests.

6. Retardation as a school problem must shortly be re-studied in the light of the newer facts of individual differences brought forward by the use of intelligence tests and other objective measures.

7. In the majority of cases, pupils classified as retarded by the usual standards are really accelerated upon the basis of mental age, and the reverse is true for accelerated pupils.

8. Accelerated pupils, although actually younger, are able to more than maintain their position in competition with children who are ''at age'' as is shown by school marks, but retarded pupils do not succeed in holding their own in their class in spite of their greater age.

9. Retarded pupils furnish about three-fifths of the total failures of the school.

10. The pupils of the University High School show satisfactory abilities in all school subjects tested except arithmetic and writing. In the case of the former the reason was proved to lie in poor instruction in the lower grades.

11. Boys are slightly inferior to girls as measured by the grades received in school. The range of grades is somewhat larger in the case of the girls.

12. The results of the Stone tests seem to indicate that the difficulties in arithmetic are to be diagnosed as inability to handle the fundamental processes in contrast with the ability to reason.

13. The physical measurements show that the Oregon pupils are both taller and heavier than eastern children. The only published norms which approximate the results for the western children are those of Baldwin.

14. The most marked superiority of the University High School pupils in the physical traits studied was found to be the much better development of lung capacity and the vital index.

15. The new method of correlating physical and mental traits advocated here seemed to indicate the presence of correlation between the vital index and intelligence.

16. Strength of grip did not seem to show relation with intelligence, at least not in the case of girls.

17. The possibility of the use of intelligence tests and tests of pedagogical accomplishment as the basis for promotions, grading, and similar questions of school progress, is rapidly becoming evident as a method of surmounting the lock-step evil in education.

18. Forced promotions, where unavoidable, can be made with a high degree of reliability by the use of objective measures.

19. Correlations of abilities in school subjects with general intelligence show the highest coefficients in the language and reasoning tests and the lowest in spelling and writing. School marks and arithmetical ability are intermediate.

20. The grading system of the University High School is probably too severely enforced at the upper ranges as is shown by superimposing the best-fitting normal curve on the actual distribution. There is also some evidence that the superior child fails to approach maximal efficiency as closely as do less able pupils.

THE DERIVATION AND STANDARDIZATION OF A SERIES OF DIAGNOSTIC TESTS FOR THE FUNDAMENTALS OF FIRST YEAR ALGEBRA

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The Derivation and Standardization of a Series of Diagnostic Tests for the Fundamentals of First Year Algebra

SECTION I

THE PURPOSE AND LIMITS OF THE STUDY

The last decade has witnessed the development of a new phase of educational study and research—that of the development of means of objective and standard measurement of school achievement. That there is a demand for a means of such measurement cannot be questioned. The considerable attention and study given the matter by research students of education in the last few years testifies to the fact. Already there have been devised scales or tests for practically every subject taught in the elementary schools and for many of the secondary schools. Practically every issue of a large number of our educational journals contains some article, communication, discussion or review relating to educational measurements. Bureaus of research and efficiency and organizations by other and similar names exist at a number of the state educational institutions and in many city school systems. Each year witnesses the contribution of new scales and tests, and wider use of these scales and tests is continually being made.

Instruments of measurement are as badly needed for secondary school subjects as for those of the elementary school. Furthermore, the subject of algebra as commonly taught in the high school, no less than other subjects, demands adequate means of measurement and it is quite apparent that proficiency in the operations of high school algebra lends itself admirably to fairly accurate objective measurement. There are already in use several scales or series of tests for evaluating proficiency in first year algebra.* However, as will be pointed out later, there are certain features of each of these scales, which detract from their value as scientific and practical devices for measurement of school achievement.

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*See list of such scales in appendix.

It is the purpose of this study to do the following things: First, to determine what seems to be the fundamental formal processes in first year algebra as commonly taught in the secondary schools of the United States; second, to select for each such fundamental process a number of problems which require for their solution varying degrees of mastery of these fundamental processes in their various schoolroom aspects; third, to standardize the results obtained by giving the problems so selected to a large number of first year high schools students, so that definite objective standards of attainment may be set up; and fourth, to point out the uses and values, and limitations of tests so devised.

No attempt will be made to justify the retention of first year algebra in the curriculum of secondary schools, its present placing, the content of the subject as commonly taught or the methods of teaching it. Nor will it be claimed for the tests derived from this study, that they are a measure of the ability to use algebra in its functional applications other than may be inferred from a test of proficiency in the abstract formal operations in the typical schoolroom situation.

It is on the other hand our problem to devise a series of tests which will furnish as an aid to teaching, supervision and administration, an adequate means of measurement and diagnosis of ability and weakness in proficiency of those to whom the tests are applied in those formal operations of first year algebra, which from the consensus of opinion of a large number of competent authorities seem to constitute the fundamental operations of algebra, as addition, subtraction, multiplication and division are commonly accepted as constituting the four fundamental operations of arithmetic.

SECTION II

THE FUNDAMENTALS OF FIRST YEAR ALGEBRA

At the outset of an attempt to set up standards of measurement for any object or process, one must settle definitely just what one expects to test. The nature of the scale obviously will depend upon the nature of what is to be tested. For example, bodies of huge size must be measured in terms of large units. Distance is measured by linear scale, short distance by feet and inches, larger distances by miles.

Further, when one says that object A is of a certain length, one does not set up that particular length as a sum total of object A.

The particular distance measures length only, and gives little if any indication as to the width, depth, shape, color, hardness, weight or value, or even to suggest that it has these qualities.

Courtis would not be so careless as to suggest that his Standard Research Tests in Arithmetic measure arithmetic ability in general, except in a very rough way. The ability to add, subtract, divide and multiply does not give definite assurance that the possessor of that ability can solve problems in taxes, denominate numbers or insurance, although one may be reasonably sure that he, who cannot add, subtract, divide and multiply fairly well, cannot work such problems.

Similarly, all devisors of scales and tests must determine for themselves at the outset just what knowledge or ability they are setting out to test. It follows very naturally that he who would devise a series of tests for testing ability in the formal processes of algebra must follow one of two courses—to develop a test to measure algebra ability in its entirety, a seemingly impossible and impracticable task, or, to develop a number of tests each to measure ability in one of the several processes or elements of algebra, and from a combination of the results of these several tests form a fairly accurate estimate of the ability in the whole of algebra much as one forms an opinion of the ball playing ability of a player by observing him bat, run bases, field, and throw in separate instances—an opinion very likely to be fairly accurate.

The question of selecting the elements to be tested presents itself. Without a doubt the elements selected should be fundamental. Hence, the problem resolves itself into determining what constitutes the fundamentals of algebra. One could easily formulate what he considers the fundamentals of algebra with entire satisfaction to himself as some devisors of algebra scales have done. But another, equally well prepared to pass upon the matter, might not make the same selection. In fact this has proved to be exactly the case.

Monroe selected the algebraic abilities to be measured in his "Standard Research Tests in Algebra," by "analyzing the solution of simple equations containing fractions with numerical denominators and numerical coefficients."* He discovered there to be five distinct types of examples in the process of solving simple equations containing fractions with numerical denominators and numerical coefficients.

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*"Measurement of Certain Algebraic Abilities," School and Society, Vol. 1, p. 393.

1. Multiplication of binomial by monomial factor—
   e. g., $6(3x-2)$.
2. Reduction of fractions to common denominator—
   e. g., $\frac{7x-2}{6} - \frac{8x-1}{8}$
3. Transposition.
4. Collection of terms.
5. Division, of this type: $-15x=30$, to find x.

For each of these types he constructed a test and also one for the complete solution of simple equations of the type previously mentioned.

Rugg and Clark in their report of the derivation of their "Standardized Tests in First Year Algebra," discuss the method by which they selected the fundamental operations of first year algebra as follows: .*

> We next give a mere list of the fundamental operations of first year algebra which should be tested:
>
> 1. Removal of parenthesis
> 2. Combining terms
> 3. Subtraction
> 4. Evaluation
> 5. Special products
> 6. Factoring
> 7. Exponents
> 8. Clearing of fractions and fractional equations
> 9. Quadratic equations
> 10. Graphing of equations
> 11. Solution of practical formula
> 12. Simultaneous equations.

The tests as they eventually stood, however, were as follows:

1. Collection of terms
II. Substitution
III. Subtraction
IV. Solution of simple equations
V. Removal of parentheses
VI. Special products
VII. Exponents
VIII. Factoring
IX. Clearing of fractions
X. Solution of fractional equations
XI. Manipulation of formulae
XII. Solution of quadratic equations
XIII. Solution of simultaneous equations
XIV. Reduction of radicals
XV. Graphs
XVI. Solution of quadratic equations

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*"Standardized Tests and the Improvement of Teaching in First Year Algebra." School Review, Vol. 25, p. 113.

It should be noted that division, multiplication and solution of simple equations (the latter being the process emphasized in the Monroe Tests) are not included in the fundamental operations as selected in the research of Rugg and Clark.

In the Indiana University Algebra Tests arranged by H. G. Childs, the following method was used in the selection of the tests:

> A series of twelve tests were arranged, based largely on the Monroe Tests which had been used in the schools of Kansas during the year. The Monroe Tests were added to by the inclusion of tests in formal subtraction of polynomials (Test I), long division (Test IV), easy and difficult problems to be stated in the form of equations, (Tests VII and XII), factoring Test X) and solving simultaneous linear equations (Test XI). Test B of the Monroe series was slightly modified, and calls for the clearing of fractional equations of fractions (Test VIII).*

Of the manner in which the operations for which tests were devised by Stromquist of the University of Wyoming, no report could be found. They are, as taken from the tests:

1. Application of formulae
2. Division
3. Simple equations in one unknown
4. Simple simultaneous equations
5. Factoring
6. Numerical substitutions

Hotz chose to devise tests for the following operations:

1. Addition and subtraction
2. Multiplication and division
3. Equation and formula
4. Problems (verbal)
5. Graphs

In the report of the study, no reason is given for the selection of these operations.†

It is noticeable that no two investigators in this field have reached on agreement as to what operations of algebra should be tested in an algebra scale.

One then finds himself wondering whose selection is most worth while. It is a fairly well established principle of scientific investigation that the aggregate opinion of a large number of competent judges is a more reliable index than any one individual opinion. A questionnaire was prepared‡ and sent to one hundred of the charter members of the Mathematical Association of America. The names of these members were selected so as to give a proper geographical distribution, (see Table I) and to include some instructors teaching in each of secondary and normal schools, colleges and universities. Owing to the facts that the addresses were two years old at the time copies of the questionnaire were sent, and that many of those to whom they were sent had gone into national service, but fifty-nine replies were received.

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*"The Measurement of Achievement in Algebra." Proceedings of Third Annual Conference on Educational Measurements. Bulletin of the Extension Division, Indiana University, Vol. II, p. 171.

†Hotz, H. G. "First Year Algebra Scales." Contributions to Education, No. 90, 1919.

‡See Appendix for copy of questionnaire.

TABLE I

Geographical Composition of Those Making Replies to Questionnaire to Determine Fundamentals of First Year Algebra:

	In Schools of College Grade	In Schools of Secondary Grade	Total
New England	3	6	9
Atlantic States	6	6	12
Southern States	2	2	4
North Central States	9	12	21
South Central States	2	2	4
Rocky Mountain States	2	2	4
Pacific Coast States	3	2	5
	27	32	59

TABLE II

Frequency Tabulation of Replies to Questionnaire to Determine Fundamentals of First Year Algebra:

	Instructors in Colleges and Universities	Teachers in Secondary Schools	Total
Collection of terms	27	32	59
Division	27	31	58
Multiplication	27	31	58
Solution of simple equation	26	28	54
Solution of simultaneous linear equations	19	22	41
Factoring of type forms	19	21	40
Solution of simple quadratics	18	20	38
Graphing	17	17	34
Transposition	13	16	29
Exponential manipulation	11	14	25
Expansion of binomials	12	13	25
Clearing of fractions	11	14	25
Radicals	12	12	24
Ratio and proportion	10	9	19
Evaluation of formulas	3	3	6
Forming equations	4	1	5

Table II shows a classification of the replies according to the fields of work of those sending in replies as well as a summary of the fundamentals selected by those answering.

Several facts of interest, though of minor significance, will be noted from this table.

1. The fifty-nine replies of which the authors are known are almost equally divided between teachers engaged in high school work and those employed in higher institutions, there being thirty-two and twenty-seven of these, respectively.

2. The totals for each fundamental are almost equally divided between the two classes of educators differing in no item by more than five, the median difference being three.

3. The number of those including graphing is surprisingly small in view of the recent tendency to emphasize that phase of mathematics more than formerly.

4. Only six replies insisted upon evaluation of formulae as a fundamental though this is probably one of the most practical uses of algebra.

5. There seemed to be a very marked dividing line between those things of primary and those of secondary importance as seen from the frequency table—59, 58, 58, 54, 41, 40, 38, etc.*

6. The general tendency seemed to include the processes of clearing of fractions and transposition in that of the solution of simple equations, though the solution of many simple equations do not include those steps.

7. The removal of parentheses, not suggested in the questionnaire, was named in but one reply.

Many of those answering were kind enough to write out brief explanations or observations which were very interesting, but not pertinent to the purpose of this study.

From the viewpoint of a selection of certain elements of algebra, predominantly fundamental, the results tabulated from the replies were very satisfactory. The following processes stand out clearly above the others as such as shown in Table II.

1. Collection of terms (addition and subtraction).
2. Multiplication.
3. Division.
4. Solution of the simple equation.

It was decided to attempt to construct tests to evaluate ability in these particular lines. These tests, four in number, are referred to as series A.

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*See Table II.

Addition and subtraction are included under the one head of "Collection of Terms," as the two processes are identical in algebra with the exception of the changing of the sign of the subtrahend in subtraction. To those who object that the solution of the simple equation includes the three other fundamentals, it must be pointed out that all equations do not include each of those steps and that in those that do, it is at least extremely difficult to control the test so that ability in each process may be differentiated and evaluated separately. Those who wish to test the pupil, class or school in general skill in the fundamentals of elementary algebra, may use merely the test for the solution of the simple equation.

Those who wish to test the various fundamentals to locate specific defects must use the tests for the individual processes. For those who would have need of testing ability or progress in those other processes not so uniformly considered fundamental, tests may easily be devised and standardized, using the accepted principles of scale derivation and standardization, employed in the derivation of the tests of Series A.

SECTION III

THE TEST MATERIAL

1. The Selection of the Exercises

It was evident from the results of the questionnaire that the four operations, collection of terms, multiplication, division and solution of simple equations are the operations which could be most fairly taken as the fundamentals of first year algebra. It remained to select exercises which will test proficiency in these operations. Exercises suited to testing the abilities to collect terms, to divide, to multiply, and to solve simple equations might have been taken from textbooks, teachers' examinations, or be invented outright.

The likelihood of securing more suitable exercises than could be obtained from textbooks was remote, so this source was utilized. To avoid any effect of practice, the exercises were taken from a number of texts and each exercise was changed in some way.*

Ten exercises were selected for each of the processes—collection of terms, multiplication, division, and solution of simple equations, and were designated respectively as Tests I, II, III, and IV, Series A.†

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*See Appendix for list of the texts from which one or more exercises were selected.
†See Appendix for copy of tests of Series A.

a. COLLECTION OF TERMS. *Test I, Series A.*

In this test as in others the exercises were selected to represent various degrees of difficulty and to involve different combinations of steps in each process.

Exercise 1, addition, was calculated to represent the simplest type of addition exercises, involving no question of signs. Exercise 2 includes the additional element of negative signs.

Exercise 3, subtraction, contains no negative signs, while exercise 4 includes this additional step.

Exercises 1 to 4 deal only with monomials, while 5 to 10 deal with polynomials. In exercises 7 and 8 there are the difficulties of arranging the terms under their likes, which does not occur in exercises 5 and 6.

Exercise 9 is a variation of additions, while exercise 10 also includes subtraction. These exercises are placed last as they test no steps not included in previous exercises and for that reason could be best omitted in cases when the pupil had not time to finish all. Five of the exercises of this test involve addition, four involve subtraction, and the other both addition and subtraction.

b. MULTIPLICATION. *Test II, Series A.*

As in Test I, the exercises of this test were selected with a view of including a variety of degrees of difficulty and the chief subordinate teaching units in each operation.

Exercise 1 is the simplest type of multiplication that may be called algebra—a positive literal by a positive numerical monomial. Exercise 2, somewhat more difficult, consists of multiplying one positive literal monomial by another, involving exponential manipulation.

In exercises 3 and 4, the multiplier is a negative quantity, hence the multiplication involves a new element, that of the laws of signs for multiplication.

In exercises 5 and 6, the process is that of finding the product of a binomial by a monomial first with a positive multiplier and then a negative one.

In exercises 7 and 8, the multiplier also is a binomial.

Exercises 9 and 10 are simply more difficult problems inserted to differentiate among the more able students.

c. DIVISION. *Test III, Series A.*

The exercises of Test III, Series A, Division, were selected as in the previous tests.

Exercise 1 consists of dividing a positive monomial by a positive monomial while in problem 2 the divisor is negative involving the law of signs, and in problem 3, the dividend is negative, in general each problem being more difficult than the preceding one.

In exercise 4, the dividend is a polynomial, the divisor a positive monomial. In exercise 5, the divisor is a negative numerical monomial and in exercise 6 a negative literal monomial. In exercise 7, the difficulty is increased by involving two literal coefficients, whereas heretofore but one has been used. Exercise 8 is even more difficult.

Exercises 9 and 10 are of a different type, being exercises where polynomial is to be divided by a binomial, involving the entirely different process of long division.

d. Solution of Simple Equations. *Test IV, Series A.*

Exercises 1 and 2 involve only the axiom that "both members of an equation may be divided by the same quantity without destroying the equality," plus a division of positive monomials by positive integers.

In exercises 3 and 4, the process involved in exercises 1 and 2 must be preceded by a single transposition and a simple collection of numerical terms.

In exercises 5 and 6, there must be accomplished a double transposition and a collection of algebraic as well as of numerical terms.

Exercises 7 and 8 involve clearing of fractions in addition to the elements involved in the previous exercises with the exception of transposition, while 9 and 10 involve clearing of fractions and transposition and are also of apparent greater degree of difficulty.

2. The Plan of Design

While the problem in these tests are arranged in a general order of apparent difficulty, it is not essential that they be so arranged except for the reason that pupils taking the test may work first the easier exercises as a "warming up" process for the more difficult ones and that they may work first the exercise they are most likely to do successfully and spend the remainder of their time puzzling over the more difficult ones.

The basis for selections lies in the attempt to secure a variety of exercises testing the various types of difficulty under each fundamental, thereby providing opportunity for diagnosis and at the same time providing opportunity for differentiation of different degrees of ability by the inclusion of exercises of varying degrees of difficulty. That is, the exercises are selected to test the different types of steps or processes included in the teaching of the fundamental operations and to involve a fairly wide range of difficulty. An examination of any of the tests will demonstrate how carefully this has been done. It is in this arrangement that the tests under discussion have a distinct and important advantage over other tests for measuring algebraic ability or progress.

At this point the bases of the selection of the exercise material of other tests and scales for algebra should be noted. The exercises of each of the Monroe Tests are of fairly equal difficulty. While evidently not exactly equal, they are not of sufficient difference in degree of difficulty to be of much service in differentiating degrees of skill. The unfortunate feature in the selection of the problems of the Monroe Tests lies in the fact that in each test they are all of one type. For example, in Test I, Multiplication, all examples are of the following type: —4(3x—4)—, a binomial consisting of a literal of the first degree and a number, multiplied by a numerical co-efficient. Few teachers of elementary algebra would be willing to accept a test restricted to this type of problem as a test of the ability to solve multiplication problems in elementary algebra. The example represents one type of a number of types of multiplication examples, none of the other types of which are tested by Test I, Multiplication, of the Monroe Tests. This characteristic is a feature of all of the Monroe Tests.

The Rugg-Clark problem material is selected with a view to meeting the requirement of a good algebra test, as they consider them to be. As the authors state:

> "Each specific test is made up of a number of examples (10 to 28) each of an elementary nature involving the operation in question. Because it is impossible to arrange separate tests for all kinds of operations involved owing to lack of time in classroom handling, etc., these examples which involve closely related operations are grouped in one test and arranged rigidly in "rotation."*

This arrangement they call the cycle principle of design. In pointing out the necessity of some principle of design in the selection of exercise material, these authors say of the Monroe Tests in the article referred to above:

> "Attention should be called to the fact that validity of other algebra tests which have been drawn up without regard to this principle (the cycle principle or rotation) should be seriously called in question. For example the Indiana Algebra Tests, based upon the Standard Research Tests devised by W. S. Monroe, sent out from the University of Indiana,

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*"Standardized Tests and the Improvements of Teaching in First Year Algebra." School Review, Vol. 25, p. 113.

> have been made up in such a way that the efficiency of pupils solving a given number of problems on any tests cannot be validly compared with the efficiency of pupils solving half as many, a third as many, twice as many, etc. To illustrate this point we reproduce Test II of this series of tests. Certainly no definite principle of design controls the placing of problems in this test. Our results show that this is an essential step that must be followed if we are to have sound criticism of school matters. It can be suggested from the results of an investigation that the problems, many of which are several times as difficult as others (problems 1 compared to problems 2, 6, 8 or 14 for example) are not put together in such a way as to lead to comparable results in testing pupils.

Whether we can agree with the above *in toto* or not, the author would point out two things emphasized:

1. The necessity for the selection of exercises on some basis which will provide for variety sufficient to test at least the chief types of each fundamental operation.

2. That the statement "must be designed in accordance with the cycle principle of rotation of problems," is said of *time* tests only. The Standard Diagnostic Tests will use time limits only incidentally as will be seen later and are not time or rate tests but power tests. (The difference between these two types of tests will be pointed out in Section IV.)

The exercise material of the Rugg-Clark Tests is open to criticism in that the "cycle" does not include a sufficient variety of problems for the purposes of diagnosis. Further, in the scoring of the exercises, they are considered as of equal value and difficulty though no experimental data is offered to substantiate this assumption. The exercise should either be shown to be of equal difficulty, of equal steps of range of difficulty, or they should be weighted on the basis of their difficulty, neither of which seems to have been done. This criticism applies alike to the exercise material of the Stromquist, Childs and Monroe as an examination of these tests will disclose. An examination of the exercises of the Standard Diagnostic Tests will disclose the evident fact that they are of varying degree of difficulty and hence effective for differentiation of ability and that they test a variety of sub-types under each test and hence add to the value of the test for purposes of diagnosis. The exercises are not selected with a view of their being equal in difficulty, but, on the contrary, on the assumption that they represent different degrees of difficulty. They are not selected to represent equal steps in the range of difficulty or merit but are to be weighted according to their relative difficulty as determined by the performance or per cent-of-pupils-solving method, as will be explained in Section IV.

SECTION IV

STANDARDIZING THE TESTS

1. The Function and Necessity of Standardization

Up to this point, with the exception of the experimental determination of what constitutes the fundamentals of algebra, we have only constructed a carefully selected series of tests or examinations for the fundamentals of first year algebra, just as any classroom teacher with care and precision might do for the purposes of an ordinary examination. As an objective, standard means of measurement the tests as yet have no value beyond that which might attach to any carefully constructed list of quiz problems. The value of the tests as objective and standard means of measurement lies in their standardization. To be intelligible, results obtained from the giving of such tests must be directly comparable to various definite standards of ability to do the tests. One must know the range and distribution of abilities of a large number of first year students on the tests before one can profit from knowing the score of an individual or a class on the tests. The questions arise as to how many, to whom, etc., the tests should be given for this purpose. To give the tests to one class, though considered a typical or average class, would hardly suffice. Results would be too largely influenced by individual variation. The larger the number of student performances obtained, the more likely the resulting standard scores will be uninfluenced by the fluctuation of scores of unusually good or poor individuals or classes. The laws of chance tend to operate more uniformly in proportion to the increasing number of cases. However, this gain from increased numbers increases first very rapidly, but the rate of increase gradually diminishes until even doubling the number of cases adds but little to the smoothing of the curve representing the distribution. Hence, after several hundred cases, additional cases have but little effect upon standards up to that point. For these reasons, it was decided to give the tests to somewhere near 1000 students. As the tests should measure algebraic abilities as they are found in all sections of the country, in large schools where teachers are likely to be better paid and probably better trained for their work as well as in small schools where the reverse is likely to be true, it was decided to have the tests given to pupils in twelve high schools of five different states—Oregon, Idaho, Missouri, Iowa and Oklahoma, and in high schools ranging from 50 to 800 pupils, including both the 8-4 and the 6-3-3 plans of organization. In order to prevent the results from the larger city schools from affecting the final standards unduly, not more than 100 tests were sent to any one school.

2. METHODS OF GIVING THE TESTS

a. Time Limits.

It has been recognized for some time that tests of mathematical ability are of two types—the time or rate test and the power or development test.* The former, of which the Courtis Research Tests in Arithmetic, the Monroe Diagnostic Arithmetic Tests, the Rugg-Clark Standardized Tests for First Year Algebra, the Monroe Research Tests in Algebra, the Stromquist Preliminary Algebra Tests, the Indiana Algebra Tests and the Coleman Scale for Testing Ability in Algebra are examples, sets a definite time limit in which no pupil however bright may complete all the exercise material. It emphasizes speed and measures ability by the quantity done. The other type, the development or power test, may or may not have specified time limits. The time element is not stressed; speed is emphasized incidentally, if at all. This type of test usually consists of a number of exercises varying from those which practically all pupils should be able to solve correctly to those which but a few could be expected to do. This type of test determines how difficult and what varieties of exercises in the field of the tests the student can solve, while the rate test determines how rapidly the pupil can solve exercises of more or less of the same difficulty and the same type.

Rugg and Clark in the chapter, ''Construction of Standardized Tests'' of their monograph referred to previously, make three distinctions between rate and development tests.

1. The rate test is a time test while the development test makes use of the time factor either only incidentally or not at all.
2. The second distinction between the rate test and development test is found in connection with grouping together of like or unlike kinds of subject matter, the rate test using like and the development test unlike problems.
3. The third distinction is found in the organization or arrangement of the parts of the test. In the development test the problems are arranged in order of increasing difficulty. Furthermore, *different kinds of ability are measured in the same test.*

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*See Rogers, Agnes L. "Tests of Mathematical Ability—Their Scope and Significance." The Mathematics Teacher, Vol. VI, pp. 145-165.

Rugg, H. O., and Clark, J. R. "Standard Tests and the Improvement of Teaching in First Year Algebra." School Review, Vol. 25, pp. 113-32; 196-213.

The present author found that he could not subscribe to the above definition of the differences between rate and development tests in the following particulars:

1. The development test need not group together unlike subject matter. The grouping may be of problems testing the same subject matter but of varying degree of difficulty. The authors referred to above cited the Woody Scale for Arithmetic and the Thorndike Algebra Scale, both of which group in the same test several types of subject matter; however, this feature is not an essential of a development test and the assertion that such is the case is an unfair argument for the rate type of test. Likewise, the statement that one of the essentials of the development scale or test is that it tests different kinds of ability is inaccurate. The variation consists of applying the same ability to different situations.

In the the same publication, there appears the following statement:

> Having in mind clearly, therefore, that standardized tests to be of real service to the school system, should be used primarily as *measures of learning and for teaching diagnosis,* we can now distinguish again between the rate and the development test. The rate test offers opportunity to the pupil to do the same particular kind of operation several times. The development test, on the other hand offers opportunity for the working of only one example of a particular type. In this connection, therefore, the rate test is seen to be far superior to the development test in the degree to which it enables us to put our fingers upon the specific difficulty of the pupil.

The chief function of the standardized test, the diagnosis of teaching, is the requirement that the time or rate test does not meet. The above quotation points out that the development test permits the pupil to attempt but one example of a particular type. This may or may not be true according to the plan of design of the test, but even where it is true, for the purpose of diagnosis a test which allows for a differentiation on basis of ability rather than on the basis of speed is much more to be desired than one of the latter type. The time test is scored in terms of the number of problems per unit of time. Each problem is scored equally with every other. Each problem counts one. For this reason, all problems of a rate test should require approximately the same amount of time for solution and each should be of approximately equal difficulty. And these conditions are just what are to be found in the more prominent examples of this type of test. It is superfluous to point out that, as far as diagnosis ''which enables us to put our finger upon the specific difficulty of the pupil'' is concerned, the value of a test which includes but one kind of example and problems of but one degree of difficulty, is very limited.

The matter of time limits depended upon whether the test was to be one where the thing to be tested was speed—the rate test, or whether degree of ability was the thing sought to be measured—the power test. Feeling that the chief purpose of a test lies in its value as a diagnostic instrument and that this value could be best secured by a power or development test, and that its value for other purposes was not only not lessened but probably enhanced by its being a power or development type of test, it was decided to use time limits only incidentally.

It was decided that in giving the tests, sufficient time should be allowed for all pupils, not unusually slow, to attempt all of the problems, providing they knew how, had to make no corrections, worked rapidly and wasted no time. From giving the tests to five sections of first year algebra in the Eugene, Oregon, high school, one in the University of Oregon high school, and two in the Springfield, Oregon, high school, eight sections in all, under very close supervision, it was determined that such time limits would be as follows:

Test I, between five and six minutes.
Test II, between seven and eight minutes.
Test III, between nine and ten minutes.
Test IV, between eight and nine minutes.

In order to insure uniformity in the giving of the tests, the time limits were set at 5, 7, 9, and 8 minutes for Tests I, II, III, and IV, respectively. These periods proved sufficiently long for the vast majority of all pupils taking the tests to attempt all problems, as will be seen later.

The author was not unmindful of the fact that to date, tests and scales for measuring ability in mathematics have been largely of the time or rate type and that it has been the plan of design to include in the test problem material in such quantity that no pupil could hope to complete all exercises.* The author was not unmindful of the assertions of some that such a plan of design was necessary for the complete differentiation of algebra ability. However, there were considerations, some of which have been stated in the preceding which seemed to outweigh whatever advantages there might attach to the rate type of test.

In the first place, one of the fundamentals of principles of any scientific study is that it be "controlled" to the extent that all influences which might affect the results of the experiment or study be eliminated, balanced, or that they be measured and accurately accounted for, in any generalization or conclusion to be made from the study. The rate test attempts to measure simultaneously accuracy and speed (power and rate). If the final score could be expressed in one unit of measurement of ability, into which accuracy and speed both entered in a known, definite relation, and the thing so measured be called, say, general algebra ability or arithmetic ability, perhaps the following observation would not be well taken, but the general practice in the scoring of the rate test is to set up from a single test two scores, one as a measure of accuracy and one as a measure of speed. It is obvious that such a procedure violates the principle of control, as it is apparent that working for a high score in speed operates to reduce the likelihood of accuracy.*

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*The Monroe, Rugg-Clark, Stromquist, Indiana Tests and the Courtis, Monroe and other arithmetic tests possess this feature.

A number of observers including Courtis, Kirby, Thorndike and others have noted that speed and accuracy go hand in hand, but from this fact there cannot be drawn a conclusion that greater speed *for the same individual,* will result in increased accuracy. On the other hand, it is obvious that there is a certain optimum rate beyond which any increase in speed will be made at the expense of accuracy. If this were equally true for all individuals, the effect of increased accuracy on speed, could be calculated and allowed for, but as Thorndike says, ''The same individual may lose in precision by increasing his speed, (though he will not always do so) . . .''† Since, then, the two factors which we have been attempting to measure simultaneously tend to interfere one with another, to an uncertain and as yet an unmeasurable extent, any score assigned to a performance where the subject is striving for the two-fold goal cannot be an accurate measure of either.

Monroe insists that mathematics is a ''two-dimensional'' subject and that any measure of mathematical ability must be two-dimensional. The author must make reservations to these statements. As far as either school work or business life is concerned a third dimension plays just as important a part as speed—that of form—but that is not the meat of the objection. Even were we to admit that mathematical ability is ''two-dimensional,'' we cannot hope to secure an accurate measure of each dimension from one measurement. Mathematical ability must be measured separately for speed and for accuracy until that time when a method of measurement is evolved which will either eliminate or control the interference of one ability with the other in a performance.

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*See "Speed vs. Accuracy in Learning." A study reported by Marguerite Broone, Augusta Spett and Geary Myers, School and Society, Vol. VIII, p. 687.

†"Relation Between Speed and Accuracy in Addition." Journal of Educational Psychology, Vol. V, pp. 537-543.

With these considerations in mind, the author was confronted with the choice of designing tests to measure speed or tests to measure accuracy. By all odds, of the two things in question, the ability worth more and the measurement of which is more to be desired is accuracy. Except for a few special occupations and rare instances in general practice. society penalizes slowness in algebraic computations only in the most flagrant instances, while absolute accuracy is essential. No amount of speed will offset inaccuracy in any activity of life where there is need for numerical or algebraic computation. The question asked by society of the man who would use mathematics is not how fast he can make computations, but are his solutions correct. While this is true of all mathematical activities, it is especially so for algebra and the higher fields. Because of these facts, it was decided to construct a series of tests for the measurement of accuracy which would use time limits only as a penalty for the unusually slow. These time limits have been previously stated.

b. Directions for Giving Tests.

In the giving of any standard tests, it is highly desirable that the conditions under which they are given be as uniform as possible. The directions and routine procedure represent the bulk of such conditions, hence, the direction for giving such tests must be planned carefully so as to insure the securing of uniform conditions and elimination of interfering circumstances. The directions for giving the tests were as follows:

DIRECTIONS FOR GIVING THE DOUGLASS ALGEBRA TESTS

1. Have pupils put away books, papers, etc., from desks and see that each has suitable pen or pencil point.

2. Pass test blanks among pupils requesting them to place sheets on desks with Test IV up and not to look at problems until the signal to begin is given.

3. Make an explanation similar to the following:

"This is an algebra test. We want to know how many of these problems you can work correctly. When I say 'start' you are to turn the sheet over and begin to work the problems of Test I. You will be given five minutes on this test which will be sufficient time for many of you to work all problems correctly if you waste no time. Work rapidly, but do not hurry. Accuracy is worth more than speed. When you have finished this test do not turn your papers over or look at the problems of any other test, but fill in the blanks at the top of the page. Be very careful not to give or receive any help as that will spoil the test. You may ask questions now but no one will be permitted to ask questions after we start. Remember work rapidly, but do not hurry."

When your watch records a convenient place to count from, say "Begin.".

4. Allow the following amounts of time for the tests: Test I, five minutes; Test II, seven minutes; Test III, nine minutes; Test IV, eight minutes.

5. In order that the testing may be valuable as a scientific experiment, it will be necessary for those giving the tests to follow directions strictly and to exercise care that no help is received by any pupil. Pupils should be made to feel at ease and not that they are to be graded by the tests or that there is any spirit of contest.

c. *Scoring the Papers.*

In scoring the papers, solutions were marked either right or wrong, this procedure being adopted arbitrarily, following the almost uniform practice of those who have developed scales or tests of mathematical ability. The number of problems solved correctly was recorded in the space for that purpose in the upper right hand corner of the test sheet. Just below this score on the test sheet there appears the numbers one to ten, corresponding to problems one to ten. For the purpose of diagnosis, each problem solved correctly was so recorded by checking the corresponding number in this space. Problems attempted but not solved correctly were recorded by the encircling of the appropriate number. Blanks were prepared and provided for the recording of the tabulated results from the tests.

3. Weighting the Tests

a. *The Method of Weighting.*

The problems chosen for the tests are clearly of unequal difficulty and have required unequal degrees of ability to solve them. It is only logical that they should be weighted for purposes of scoring according to their difficulty. A number of scales and tests including the Kelley Silent Reading Tests, the Gregory Language Tests, the Hillegas Composition Scale, and others have incorporated a system of weighting in the plan for scoring results. There have been two methods of determining the appropriate weights commonly used by scale makers. They are:

1. The judgment-of-competent-judges method. Under this plan the relative difficulty of an exercise or problem, or the relative merit of a performance is determined by proportion of judges placing it above a certain point on a scale of value to the number placing it below that point. This method was used by Thorndike in his penmanship and algebra scales.

2. The proportion-of-pupils-solving method. By this method the difficulty of an exercise is determined by the proportion of pupils solving the exercise in question. This plan was used by Woody in his arithmetic scale and by Hotz in his algebra scale, and by others.

For the determination of the relative difficulty of algebra problems, it is obvious that the latter plan is preferable. It is also obvious that to weight the problems in exact proportion to the per cent of pupils solving them is illogical. It is apparent that a problem solved by 80 per cent of a large number of pupils is not necessarily twice as easy as one solved by only 40 per cent.

Those having to deal with such questions know that since the distribution of ability in school subjects conforms fairly well to the normal frequency curve and that near the median or middle of the curve, small degrees of difference in difficulty will include large numbers of pupils, while at the extremes of the curve the reverse is true. Hence, the percentages of pupils solving each problem obtained from giving the tests must be referred to the normal probability curve, in order that co-efficients may be assigned to the various problems in proportion to their comparative difficulty.

This is usually done by translating the per cent of cases solving certain problems represented by respective areas under the frequency curve into distances along the abscissa of the frequency curve. While the method is essentially the same, workers have divided into two groups, differing only in the unit of measurement of distance along the abscissa. One group of workers, including Thorndike, Buckingham, Woody, Hotz and others have taken the P. E. or median deviation. Another group of workers including Rugg and Clark using the same method, employ the standard deviation, sigma, for the unit of measurement.

Because of the large number of scale makers using P. E. as a unit, for the sake of uniformity, it was decided to use P. E. as a unit of measurement in this study.

b. The Results of Giving the Tests.

Fourteen hundred copies of the tests were sent to fourteen high schools located in the five states, Oregon, Idaho, Missouri, Oklahoma and Iowa. Twelve of the schools responded by giving the tests and over one thousand papers were returned. The papers of one school were discarded because of irregularities in the local course of study for elementary algebra which vitiated the results from that school.

Over 50 per cent of the papers were graded by the author and assistants under his supervision. Those graded and scored by teachers in the schools where the tests were given were checked for irregularities.

Other workers on similar problems have given preliminary tests to small groups in order to secure data for determining the weighting before giving the tests to a larger number of cases for standard scores. If it is desirable to include a large number of cases for the determination of the standard scores in order that the effect of individual variations might be reduced to a minimum, it is equally desirable for the same reason to use a large number of cases in gathering the preliminary data. For this reason, the weights and standard scores in some of our standard tests are open to question. Again, there is no necessity for determining the relative difficulty and weights of the problem before giving them to secure standard scores. There is only the question as to whether the arrangement of the problems should be in the order of their difficulty. While there may be something said in favor of having the easier problems first, it is not true that it is essential or even desirable to have the problems in the exact order of difficulty. The problems of the tests of Series A are arranged in the general order of their difficulty as evidenced by the order in which the various processes of solution are taught. Beyond this, any more exact arrangement is apparently worthless.

By securing the weighting co-efficients and the standard scores from the one testing, it was possible to secure a larger number of papers for the weighting than is usual, the giving of the tests especially for weights was obviated, and it eliminated the possibility of practice effects which might result in repeating the tests with the same individuals for standard scores after having given them once for the purpose of determining the relative difficulty of and weights for the test problem.

The usual custom of high school instructors in marking algebra papers is to consider each problem the equivalent of every other. Problems are not weighted according to difficulty. Had this plan been followed in determining standard scores for the tests, the work entailed in weighting the problems might have been avoided. The papers could have been graded on a scale of 10, allowing a unit for each correct solution, scores computed on this basis, and central measures and measures of variability computed as standard scores. Such a process would show the results seen in Table IV.

TABLE IV

Distribution of Scores of Individuals According to Number of Problems Solved.

Number solved	0	1	2	3	4	5	6	7	8	9	10
Test I	20	12	34	60	56	118	144	152	130	128	84
Test II	2	5	10	16	19	74	110	144	241	267	50
Test III	8	49	53	62	64	71	103	150	148	129	101
Test IV	12	14	39	47	104	142	238	139	85	60	58

Test I		Test II	
Median	7.1513	Median	8.3693
Quartile	2.2177	Quartile	1.5758

Test III		Test IV	
Median	7.3933	Median	6.4664
Quartile	2.4839	Quartile	.9578

But an exact measurement of algebraic ability could not be gotten by a plan based upon the principle of scoring the problems as each equivalent to the other. While the current classroom practice is just that, and no doubt a fairly accurate idea of ability may be obtained through such a procedure, such a measurement would not be exact since different problems called for different degrees of algebra ability and measurement would lack in precision in proportion to the variation in that respect. Hence, true scores must be obtained by using weighting co-efficients for the problems. These co-efficients must obviously be in proportion to the relative difficulty of the problems. To begin such a determination of proper weights we must know first the proportion of pupils solving each problem of those attempting them.

It might be seen that this may be obtained from the ratio of number of correct solutions for each test to the number of papers. However, a careful examination of the papers showed that the time limits prevented a number of slow workers from attempting all problems of the tests. Table V shows the number of cases by problems of students unable to attempt the various problems.

TABLE V

Number Unable to Attempt Certain Problems.

Test I		Test II	
Problem 1	0	Problem 1	0
Problem 2	0	Problem 2	0
Problem 3	0	Problem 3	0
Problem 4	0	Problem 4	0
Problem 5	0	Problem 5	0
Problem 6	0	Problem 6	0
Problem 7	0	Problem 7	0
Problem 8	14	Problem 8	4
Problem 9	80	Problem 9	20
Problem 10	154	Problem 10	154

Test III		Test IV	
Problem 1	0	Problem 1	0
Problem 2	0	Problem 2	0
Problem 3	0	Problem 3	0
Problem 4	0	Problem 4	0
Problem 5	0	Problem 5	0
Problem 6	0	Problem 6	2
Problem 7	0	Problem 7	24
Problem 8	16	Problem 8	60
Problem 9	62	Problem 9	120
Problem 10	186	Problem 10	212

It is evident that for the purpose of determining the relative difficulty of the individual problems through the proportion of failures, the per cent of failures can be computed by dividing the number of failures by the number of actual attempts. Each pupil attempted the first few problems of each test, but there were a considerable number, as shown in Table V, who did not attempt the latter problems of each test. For this reason the number of those failing to reach each of the last problems was deducted from the total number of papers in that test and the per cent of failures computed from the revised figures as shown in Table VI.

TABLE VI

Number and Per Cent Failing on Each Problem.

Test I

	No. of Attempts	Number Failing	Per Cent Failing
Problem 1	938	110	11.73
Problem 2	938	146	15.56
Problem 3	938	176	18.78
Problem 4	938	502	53.52
Problem 5	938	214	22.81
Problem 6	938	380	40.52
Problem 7	938	348	36.42
Problem 8	924	464	50.22
Problem 9	858	258	30.07
Problem 10	758	304	40.11

Test II

	No. of Attempts	Number Failing	Per Cent Failing
Problem 1	938	14	1.49
Problem 2	938	56	5.96
Problem 3	938	80	8.51
Problem 4	938	106	11.29
Problem 5	938	90	9.45
Problem 6	938	124	13.03
Problem 7	938	226	23.92
Problem 8	934	372	39.83
Problem 9	918	486	52.92
Problem 10	786	652	82.95

Test III

	No. of Attempts	Number Failing	Per Cent Failing
Problem 1	938	54	5.76
Problem 2	938	210	22.39
Problem 3	938	290	30.91
Problem 4	938	258	27.50
Problem 5	938	326	34.74
Problem 6	938	336	35.79
Problem 7	938	426	45.42
Problem 8	922	394	42.73
Problem 9	876	458	52.28
Problem 10	752	358	47.60

Test IV

	No. of Attempts	Number Failing	Per Cent Failing
Problem 1	938	18	1.92
Problem 2	938	14	1.49
Problem 3	938	94	10.02
Problem 4	938	222	23.66
Problem 5	938	336	35.82
Problem 6	936	150	16.13
Problem 7	914	660	72.21
Problem 8	878	598	68.12
Problem 9	818	610	74.57
Problem 10	726	548	75.48

Table VII shows the deviation from the median achievement of each problem. The values are obtained by computing the distance above or below 50 per cent, that of the per cent of pupils failing for each problem of each test as these per cents appeared from Table VI.

TABLE VII

Difference Between Fifty Per Cent and the Per Cent That Failed on Each Exercise.

Test I

	Per Cent Failing	Difference
Problem 1	11.73	—38.23
Problem 2	15.6	—34.4
Problem 3	18.78	—31.2
Problem 4	53.52	+3.5
Probleb 5	22.81	—27.2
Problem 6	40.52	—9.5
Problem 7	36.42	—13.6
Problem 8	50.22	+0.2
Problem 9	30.07	—20.
Problem 10	40.11	—9.9

Test II

	Per Cent Failing	Difference
Problem 1	1.49	—48.6
Problem 2	5.96	—44.
Problem 3	8.51	—41.5
Problem 4	11.29	—38.7
Problem 5	9.45	—40.5
Problem 6	13.03	—37.
Problem 7	23.92	—26.1
Problem 8	39.8	—10.2
Problem 9	52.9	+2.9
Problem 10	83.	+33.

Test III

	Per Cent Failing	Difference
Problem 1	5.8	—44.2
Problem 2	22.4	—27.6
Problem 3	30.9	—19.1
Problem 4	27.5	—22.5
Problem 5	34.74	—15.3
Problem 6	35.8	—14.2
Problem 7	45.4	—4.5
Problem 8	42.73	—7.3
Problem 9	52.3	+2.3
Problem 10	47.6	—2.4

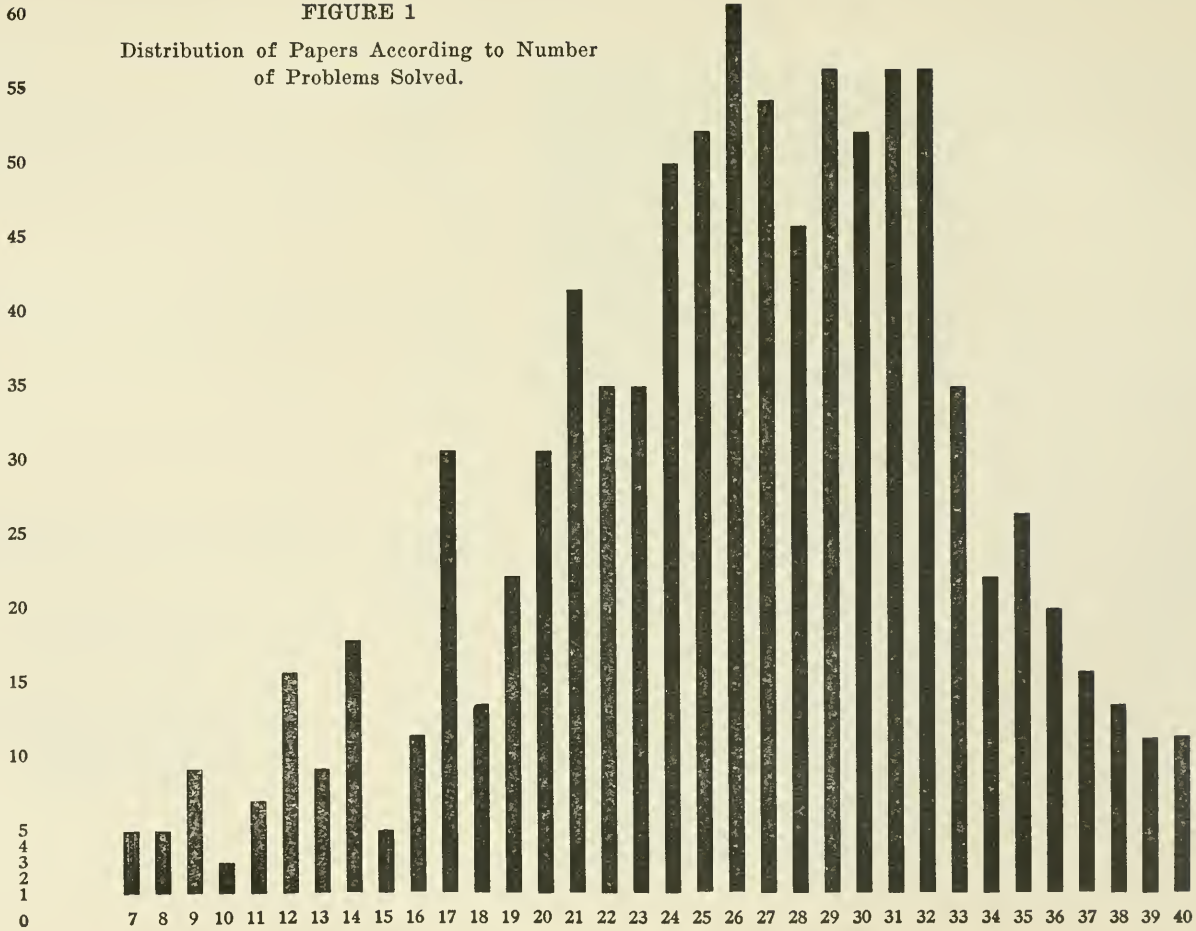
Test IV

	Per Cent Failing	Difference
Problem 1	1.9	—48.
Problem 2	1.5	—48.5
Problem 3	10.	—40.
Problem 4	23.7	—26.3
Problem 5	35.8	—14.2
Problem 6	16.1	—33.9
Problem 7	72.3	+22.3
Problem 8	68.12	+18.1
Problem 9	74.6	+24.6
Problem 10	75.5	+25.5

As explained in the section dealing with the method of weighting the problems according to difficulty, the next step was to translate the per cents of differences as shown in Table VII into P. E. equivalents representing the distance along the base line of the frequency curve under the area of the curve representing the per cent of failure. As pointed out at that time, we must first assume

FIGURE 1

Distribution of Papers According to Number of Problems Solved.



that the distribution of ability in algebra among students in first year high school classes conforms approximately to the curve. Table VIII gives a tabulation of the distribution by the number of problems worked in all four tests. (Fig. 1 represents these facts by a column diagram and Fig. 2 represents them with a distribution curve).

FIGURE 2

Frequency Curve Showing Distribution of Papers According to Number of Problems Worked Correctly

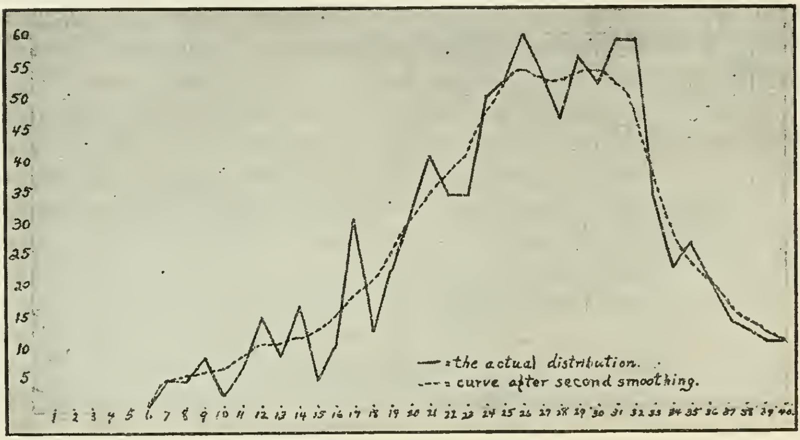


TABLE VIII

Distribution of Ability to Work the Test Problems

No. problems solved correctly	No. pupils solving that number	No. problems solved correctly	No. pupils solving that number
1	0	21	40
2	0	22	34
3	0	23	34
4	0	24	50
5	0	25	52
6	0	26	60
7	4	27	54
8	4	28	46
9	8	29	56
10	2	30	52
11	6	31	58
12	14	32	58
13	8	33	34
14	16	34	22
15	4	35	26
16	10	36	20
17	30	37	14
18	12	38	12
19	22	39	10
20	30	40	10

While the distribution curve as shown in Fig. 4 does not conform exactly to the normal frequency curve, it is evident that the distribution closely resembles that of normal frequency or probability. Making the assumption that algebraic abilities of first-year high school pupils distribute themselves after the normal frequency distribution,* we may then proceed to translate the differences between 50 per cent and the per cent that solved each exercise in each test as shown in Table VII into M. D. or P. E. values. This translation is made in Table IX.

TABLE IX

P. E. Equivalents of Differences Between Fifty Per Cent and the Per Cent That Failed.

Test I

Problems	Differences	P. E. Equivalent
1	—38.3	—1.765
2	—34.4	—1.4999
3	—31.2	—1.307
4	+ 3.5	+ .130
5	—27.2	—1.105
6	—69.5	— .357
7	—13.6	— .516
8	+ .2	+ .007
9	+20.0	+ .778
10	+99.9	+ .372

Test II

Problems	Differences	P. E. Equivalent
1	—48.6	—3.300
2	—44.0	—2.305
3	—41.5	—2.035
4	—38.7	—1.795
5	—40.5	—1.944
6	—37.0	—1.670
7	—24.1	—1.052
8	—10.2	— .383
9	+ 2.19	+ .108
10	+33.0	+1.415

Test III

Problems	Differences	P. E. Equivalent
1	—44.2	—2.331
2	—27.6	—1.130
3	—19.1	— .735
4	—22.5	— .886
5	—15.3	— .583
6	—14.2	— .539
7	— 4.5	— .168
8	— 7.5	— .273
9	+ 2.3	+ .088
10	— 2.4	— .080

Test IV

Problems	Differences	P. E. Equivalent
1	—48.0	—3.044
2	—48.5	—3.219
3	—40.0	—1.900
4	—26.3	—1.047
5	—14.2	— .539
6	—33.9	—1.469
7	+22.3	+ .878
8	+18.1	+ .698
9	+24.6	+ .982
10	+25.5	+1.024

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*See Hotz, Gustave H. "First Year Algebra Scales," p. 45, and Rugg, H. O., "Statistical Methods Applied to Education," p. 225.

c. Establishing the Zero Point.

So far what we have done is to locate each exercise a certain number of P. E. above or below the median performance of the group. In order that the exercises may be assigned values on an absolute scale so that we may know, for example, just what exercise requires twice as much algebra ability as another exercise—it is necessary for us to locate a zero point. The zero point, theoretically, is that point at which an exercise requiring no algebra ability is found. This would be different, obviously, for the different tests. Since there is no known absolute zero point for algebra—the zero point must then be established more or less arbitrarily. The two following methods are in established usage for this procedure.*

1. In Test I as shown in Table IV, 10 of the 938 students made a score of zero. Between these students and the median of the group there were 459 students or 47.87 per cent of the whole group. The distance from the median then along the abscissa of the curve representing this distribution may be translated from 47.87 per cent by the table into 3.015 P. E. The zero point by this method then would lie 3.015 P. E. below the median.

2. A second method for determining the location of the zero point would be as follows: In the normal frequency distribution the quartile is equal to 1 P. E. The distance from the median to the zero point could be expressed in units of P. E. by dividing the score for the median by the quartile, which for Test I would be

$$\frac{7.1513}{2.2177} = 3.224 \text{ P. E.}$$

Probably better than taking either of these distances would be taking the average of the distance of these two zero points from the median which would be 3.12 P. E.

In a similar fashion the zero points for the other tests were found to be as follows: Test II, 4.955 P. E.; Test III, 3.439 P. E.; Test IV, 5.029 P. E.

Since Exercise 1, Test I was shown in Table VIII to be located 1.765 P. E. below the median, it would then place 1.355 P. E. above the zero point† and that figure would then represent the actual location of that exercise on an algebra scale constructed from Test I.

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*These methods have been used by Hotz in his "First Year Algebra Scale," by Woody in his Arithmetic Scale, Trabue in his "Completion-Test Language Scales," and others.

†Found by subtraction of 1.765 P. E. from 3.12 P. E.

The location and final values for each exercise in Test I are shown in Table X.

d. The Weights and Standard Scores.

Table X shows the distance in terms of P. E. of each problem from the zero points so determined. These values, expressed only to the nearest tenth represent the true and final value as to difficulty of each problem in each test as measured from the zero point of that particular test.

TABLE X

Final Values in P. E. of Each Problem of Each Test. (To nearest tenth only.)

Test I	
Problem 1	1.4
Problem 2	1.6
Problem 3	1.8
Problem 4	3.3
Problem 5	2.0
Problem 6	2.8
Problem 8	2.6
Problem 8	3.1
Problem 9	3.9
Problem 10	3.5
Perfect	26.0

Test II	
Problem 1	1.7
Problem 2	2.7
Problem 3	2.9
Problem 4	3.2
Problem 5	3.0
Problem 6	3.3
Problem 7	3.9
Problem 8	4.6
Problem 9	5.1
Problem 10	6.4
Perfect score	37.1

Test III	
Problem 1	1.1
Problem 2	2.3
Problem 3	2.7
Problem 4	2.6
Problem 5	2.9
Problem 6	2.9
Problem 7	3.3
Problem 8	3.2
Problem 9	3.5
Problem 10	3.4
Perfect score	27.9

Test IV	
Problem 1	2.0
Problem 2	1.8
Problem 3	3.1
Problem 4	4.0
Problem 5	4.5
Problem 6	3.6
Problem 7	5.9
Problem 8	5.7
Problem 9	6.0
Problem 10	6.0
Perfect score	41.9

It is customary to express standard scores in terms of medians. To determine the median score of the 938 papers involved would mean the re-scoring of each paper using the weighting co-efficients derived. In a distribution involving nearly a thousand cases and where the extent of variation of extreme cases would not be sufficiently excessive to give undue weight to such cases, the advantages of the median over the mean as a measure of central tendency disappears owing to the fact that the two measures tend to coincide.

The mean score on each test may be determined as shown in Table XI.*

TABLE XI

Standard Scores in Terms of the Mean.

Test I

	Weight	No. of Correct Solutions	Product
Problem 1	1.4	828	1159.2
Problem 2	1.6	792	1267.2
Problem 3	1.8	762	1371.6
Problem 4	3.3	436	1438.8
Problem 5	2.0	724	1448.0
Problem 6	2.8	558	1562.4
Problem 7	2.5	590	1524.0
Problem 8	3.1	460	1426.0
Problem 9	3.9	600	2340.0
Problem 10	3.5	454	1589.0
Total of 938 papers,			15,227.23
Mean score,			16.23

Test II

	Weight	No. of Correct Solutions	Product
Problem 1	1.7	924	1576.8
Problem 2	2.7	882	2381.4
Problem 3	2.9	818	2372.2
Problem 4	3.2	832	2662.6
Problem 5	3.0	848	2544.0
Problem 6	3.3	814	2686.2
Problem 7	3.9	712	2776.8
Problem 8	4.6	562	2585.2
Problem 9	5.1	432	2103.0
Problem 10	6.4	134	857.6
Total of 938 papers,			22,539.8
Mean score,			24.03

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*The author will be pleased to receive results obtained by investigators using one or more of these tests at any time of the year. Revised forms will be published from time to time. Copies of the tests, with directions and record sheets may be had from the University Co-op. Store, Eugene, Oregon.

Test III

	Weight	No. of Correct Solutions	Product
Problem 1	1.1	884	972.4
Problem 2	2.3	728	1674.4
Problem 3	2.7	648	1749.6
Problem 4	2.6	680	1768.
Problem 5	2.9	612	1774.8
Problem 6	2.9	602	1745.8
Problem 7	3.3	512	1689.6
Problem 8	3.2	528	1689.6
Problem 9	3.5	418	1463.
Problem 10	3.4	394	1339.6
Total for 938 papers.			15866.8
Mean score			16.91

Test IV

	Weight	No. of Correct Solutions	Product
Problem 1	2.	920	1840.
Problem 2	1.8	924	1363.2
Problem 3	3.1	844	2616.4
Problem 4	4.0	716	2864.
Problem 5	4.5	602	2709.
Problem 6	3.6	786	2829.6
Problem 7	5.9	254	1498.6
Problem 8	5.7	280	1596.
Problem 9	6.0	208	1248.
Problem 10	6.0	178	1068.
Total for 938 papers			19632.8
Mean score			20.93

SECTION V

VALUES AND LIMITATIONS OF THE TESTS

1. THE FINISHED TESTS

The finished tests may be briefly described in the following manner. They comprise a series of four sets of ten exercises each devised to test four formal operations of elementary algebra as it is usually taught in the first year of secondary schools, which operations were selected as the essential fundamentals of elementary algebra by the combined judgment of competent judges. The exercises are selected so as to provide tests for all the principle teaching units and phases of each operation and at the same time to provide problems of a wide range in difficulty. The first part of this statement may be verified by an examination of a number of algebra elementary texts; the latter part may be seen from the tabulated results showing the relative difficulty of the problems. The tests are to be given with a uniform procedure and under natural conditions. From giving the tests, no measure of speed may be obtained further than the fact that the extremely slow are penalized. The resulting scores are a measure of power, not of speed. Each problem has an assigned weight, to be regarded in scoring papers, which weight is determined by, and is directly in proportion to, the relative difficulty of the problem. These are the Douglass Standardized Diagnostic Algebra Tests.

2. THE VALUES OF THE TESTS

The values of the tests lies in their use. The tests may be employed for the following purposes, among others:

1. To measure the algebra ability of the individual.
2. To measure the teaching ability of the teacher.
3. To measure the efficiency of methods of teaching.
4. To measure the efficiency of the text.
5. To check on the teaching just done.
6. To locate the weakness of the pupil.
7. To diagnose the weakness of the pupil or class.
8. To furnish data for prognosis and educational guidance.

Features of the tests make them well adapted to a number of the above functions.

The selection of the problem material was so made that the allotment of problems catalogue rather pedagogically the outstanding teaching units of the various topics and hence makes possible a more direct check on the customary type of classroom activity. Similarly the problems conform closely to teaching method and text arrangement. The tests measure power, the thing in which the teacher, the supervisor and the administrator are primarily interested. The wide range of types of problems makes possible a more accurate and specific diagnosis of weakness or difficulty, which adds materially to the value of any test in schoolroom practice. The method of scoring the papers offers a convenient way of recording the results in this respect.

By means of such tests as the Douglass tests, class grades may be assigned with more precision, the personal element in marking pupils may be eliminated, and pupil progress more accurately determined. Newer teaching methods may be justified or condemned on some basis other than unmeasured observation and guesswork and teaching efficiency thereby increased. Textbooks may be subjected to the acid test—that of the accomplishment of their functional purpose. It will be possible for the instructor in elementary algebra to satisfy himself whether the work has been sufficiently thoroly done that the class should proceed to other topics. If the results are not satisfactory, not only is the degree of proficiency measured, but the exact and specific teaching weakness or difficulty is brought into relief. Provision for individual differences and for individual instruction becomes possible thru diagnosis.

The work of algebra classes may be subjected to quantitative measurement. Scientific studies of teaching costs may be made. The teacher may justify herself in the light of results instead of general impression and popularity. The administrator may show results in a scientific and business-like manner.

3. THE LIMITATIONS OF THE TESTS

The tests have their limits and faults. No test of educational achievement however derived or constructed will constitute an exact universal, objective means of measurement such as the yardstick or the avoirdupois scale. There are values which are too general, too subtle, too abstract to be measured. Algebra is no exception to that fact.

There are, too, some limitations which apply particularly to the Douglass Tests. The tests were not intended for tests of speed. Those wishing to test speed rather than power would be compelled to use a scale or series of tests other than these. It will be noticed too that in many instances there is but one problem for a teaching unit in a test. This of course is not as desirable as a test containing more of each type, where the thing under test is the ability of the individual pupil. It should be kept in mind, however, that such is not the usual use of the standard test or scale and that, too, it is probably better to have a more complete category of problem types and a less number of problems under each than to have more problems under each of a less complete variety of types.

Again, the Douglass Tests do not distinguish sharply among that upper small group of pupils who make perfect scores. If this be a fault, the criticism is well taken.

The tests do not test the whole field of elementary algebra and are not so intended. Series A was designed especially for testing the *fundamentals* of algebra.

SECTION VI

ADMINISTRATION OF THE TESTS

Standard tests should be given under standard conditions and with standard directions for comparable results. This section will deal with the directions for giving, scoring and interpreting results from the finished tests.

Below is a copy of the revised directions for giving the tests.

DIRECTIONS FOR GIVING TESTS

1. The examiner should first of all make the following explanation:

"I am going to give you a standard algebra test. We want to see how many of these problems you can work correctly. You will need pencils with good points. (Take time for pupils to get pencils ready). I will pass out the problems now. (Have two members of the class place test papers on desks of pupils with Test I down). Do not disturb the papers at all just yet. When I say 'Begin' you will turn the papers over and begin to work the problems of Test I which is face down on your desk. Test IV is facing you. Here is the number in the upper left hand corner. Test II and III are in the inside. We will work each test separately. Does each one have a pencil with a good point? You will have five minutes to work the problems of Test I which will be time enough for you to try all the problems if you do not waste any time. Work the problems on the test paper. There is room for all your work unless you write too large. When you have finished do not turn your paper over or look at the problems of any other test. When I say 'Stop', stop at once. Before you begin I want you to fill in the blanks at the top of Test IV. You may do that now."

2. After the blanks have been filled in on Test IV, the examiner should say to the class:

"After you begin, do not ask any questions. I cannot answer them then. Are there any questions now? "

Too much time for non-essential questions should not be taken. The examiner should then say:

"Above all things do not give or receive any help. That will spoil the test. Now get ready to turn your papers over when I say 'Begin'."

3. When the hands of the watch reach an exact minute the examiner should say "Begin" and write down the time, e. g. 9:47. To this should be added 5 minutes and the time to say "Stop" is thus determined.

4. After Test I is given the following directions should be given the class:

"When I say 'Begin' this time you will turn your papers over and work the problems of Test IV. Do not turn your paper, however, until I say 'Begin'. Right now you will fill in the blanks at the top of Test I (Care should be taken that no pupil works on any of the problems at this time)."

When this is completed and the class is ready, the examiner at the exact minute says, "Begin" and calculates time as in Test I. Allow seven minutes for this test.

5. After Test IV is given the following directions should be given.

"When I say 'Begin', you will fold your papers back like this, (Illustrate by opening to Tests II and III with Tests I and IV folded in), and begin to work the problems of Test II. When you have finished do not turn your sheets until I tell you begin."

Allow nine minutes for this test.

6. After Test II has been given the examiner should give the class the instructions given above in 4, substituting the words, "Test III" for "Test IV" and "Test II" for "Test I". Allow eight minutes for this test.

7. Cautions:

Very little if any departure should be made from the above instructions. Under no conditions should any special instructions be given just before giving the tests or should any help be given any pupil while the tests are being given.

Care should be taken and a close watch made to prevent: (a) the giving or receiving of any help; (b) pupils working on the problems except between the words, "Begin" and "Stop".

The class should be made to feel at ease and natural. They should not be excited or hurried. The situation should be very similar to an ordinary daily exercise.

The tests should not be given at times when the class to be measured is in an unusual mental state such is likely to be the case just after rallies, just before athletic games, just before or just after holidays. Mondays are not the best days for giving the tests.

A slight change was made in the reprinting of the tests after their standardization. The heading of each was changed to facilitate the calculation of the individual score in terms of the assigned weights instead of in number of problems solved as in the first printing. The heading of Test I, Series A, is given below.

Test I

Series A

Collection

of

Terms

STANDARD DIAGNOSTIC TESTS
FOR ELEMENTARY ALGEBRA

Devised by H. R. Douglass

1.	..........1.4
2.	..........1.6
3.	..........1.8
4.	..........3.3
5.	..........2.0
6.	..........2.8
7.	..........2.6
8.	..........3.1
9.	..........3.9
10.	..........3.5
Score	

Name of pupil .... Age............ Grade............ Date................
City ....Building ....Teacher ....

As each problem is examined, the score is recorded by drawing a line through the numerical weighting shown in the box at the right, corresponding to the problem if wrong and by allowing the weight to stand if right. The score of the individual on each test is the sum of the weights not crossed out which is recorded opposite the word "score."

TABLE XII

Correct Answers to Problems of Tests.

Test I

1. $27m$.
2. $-2ab$.
3. $5a$.
4. $-15ab$.
5. $8a-b-9c$.
6. $9a^2-15a-5$.
7. $-5a^2+13a+3$.
8. $5x-4xy+10y$.
9. $8a^2+11a+10x+11$.
10. $-x+xy+10y+8$.

Test II

1. $18m$.
2. $12x^4$.
3. $-10a^3b$.
4. $-18a^3y^2$.
5. $8a^2b-6ab^2$.
6. $-12a^2x^2+6x^4$.
7. $32x^2+4xy-6y^2$.
8. $-28a^3x^2+12ax^3+14a^2-6x$.
9. $-12a^3bcx^2-20ab^3cdx^2+6a^2bc+10b^3cd$.
10. $63b^2y^3z^3-36a^2bcx^2yz^2+81ab^3y^2z^2+56a^2b^2c^3y^3z-32a^4bc^4x^2+72a^3b^3c^3y$.

Test III

1. $6a$.
2. $-4x$.
3. $-9x^2$.
4. $-4x^4+7x^3-6x^2+2$.
5. $-4a^3+3a^2+a$.
6. $-2x^2+4x-3$.
7. $8a^2-11ab^2-4ab^3$.
8. $-6a^2-ab+2b^2-3b^3$.
9. $3a^2+2a-4$.
10. r^2+r-12.

Test IV

1. $x=3$.
2. $y=4$.
3. $a=5$.
4. $b=2$ 2-5.
5. $r=8$ 3-4.
6. $b=5$.
7. $y=-40$.
8. $a=7$.
9. $x=-6$.
10. $x=-5$-12.

2. The Individual Record Sheet

The scores made by the individuals of the class should be recorded on this sheet. There are spaces for two sets of records, one for giving the tests the first time and one for a second time. The method of recording of these scores is apparent from an examination of the blank sheet.

INDIVIDUAL CLASS RECORD SHEET FOR DOUGLASS STANDARDIZED ALGEBRA TESTS

SERIES A

Class .... School.................................... City...............................

Teacher .... Date, 1st test........................ Date, 2nd test..................

Names of pupils	Scores on first testing				Scores on second testing				Net gain or loss (a)			
	I	II	III	IV	I	II	III	IV	I	II	III	IV
Median Score (b)												
Standard Score												

(a) This record is to be obtained by computing the difference between scores on first and second testings. Losses will be denoted by the negative sign.

(b) The median score is the score of the individual who stood half way between the poorest and the best scores in the ranking of scores. In a class having an even number of pupils, take average of the two middle scores as the median.

3. CLASS RECORD SHEET

On this sheet are spaces for recording tabulations of two sorts of results.

a. The Class Ability Frequency Tabulation. On this portion of the sheet is tabulated the individual scores in a frequency table as indicated on the blank form. Let us suppose for example the tabulation for Test I in a certain class should appear as follows:

Test I	0 to 4.9	5 to 9.9	10 to 14.9	15 to 19.9	20 to 24.9	25 to 29.9	30 to 34.9	35 to 39.9	40 to 44.9	Class Median	Standard Score
	0	1	4	13	7	1	0	0	0	17.4	16.2

The resulting table would be read as follows: Of a class of 26 pupils, one pupil made a score of 5 or more and less than 10, four made scores of 10 or more and less than 15, thirteen made scores of 15 or more and less than 20, seven made scores of 20 or more and less than 25, one made a score of 25 or more and less than 30. The median score of the class was 17.4, showing the class to have a central tendency of a higher score than that of the standard score.

b. On the same sheet is the "Diagnosis Score." This tabulation is so arranged that the scores may from the test papers tally the number of pupils solving each (not every) problem correctly. For example if the scores under Test I in the narrow column should read:

Problem 1	24	Problem 6	16
Problem 2	22	Problem 7	11
Problem 3	20	Problem 8	9
Problem 4	14	Problem 9	8
Problem 5	19	Problem 10	6

The results would be interpreted to indicate that 24 members of the class solved problem 1 correctly, 22 solved problem 2 correctly, and so on, but 3 being able to solve problem 10. The value of this tabulation for diagnosis is considerable. The problems of the tests test various phases of the general topic of the test. By the tabulated score the instructor is able to discover not only to what extent there is weakness but in what specific step or phase the weakness exists. Should it appear that a comparatively small number of the class be able to solve a certain problem of a certain test, the attention of the instructor is thereby called to that fact and the presumption is to be made that a review or further drill on the element involved in that problem is in order.

CLASS RECORD SHEET—DOUGLASS STANDARDIZED DIAGNOSTIC ALGEBRA TESTS

Section .... School .... City ....
Date .... Teacher.................................... No. pupils.................................

Class Ability Frequency Tabulation

	0 and 4.9	5 and 9.9	10 and 14.9	15 and 19.9	20 and 24.9	25 and 29.9	30 and 34.9	35 and 39.9	40 and above	Class Median	Standard Score
Test I											16.2
Test II											24.0
Test III											16.9
Test IV											20.9

In the above spaces record the number of pupils whose scores on the respective tests lie within the limits noted at the top of the columns on the various tests. Class medians may be recorded from Individual Class Record sheet.

Diagnosis Score

	Test I		Test II		Test III		Test IV	
Problem 1								
Problem 2								
Problem 3								
Problem 4								
Problem 5								
Problem 6								
Problem 7								
Problem 8								
Problem 9								
Problem 10								
Totals								

In the wider column under each test, room is provided for tallying the number of pupils working each problem correctly. In the narrower column these tallies may be totaled.

4. THE SCHOOL RECORD SHEET OF CLASS MEDIANS

On this sheet may be tabulated the medians of all sections in first year algebra for each of two testings during the year and the net gain or loss of each section. Provision is also made for recording the median of the entire school on each test.

5. INTERPRETING THE SCORES

It must be borne in mind that the standard scores of the Douglass Algebra Tests are for February results. Tests given at other times of the year must be compared with these standard scores with this fact in mind.

APPENDIX

Series A
Test 1

Collection
of Terms

Douglass
Algebra
Tests

BUREAU OF EDUCATIONAL
RESEARCH
University of Oregon

STANDARD DIAGNOSTIC TESTS
FOR ELEMENTARY ALGEBRA

Prob. 1—1.4
Prob. 2—1.6
Prob. 3—1.8
Prob. 4—3.3
Prob. 5—2.0
Prob. 6—2.8
Prob. 7—2.6
Prob. 8—3.1
Prob. 9—3.9
Prob. 10—3.5

Score

Name of Pupil .... Age........... Grade........... Date...............

City .... Building................. Teacher.........................

COLLECTION OF TERMS—(See Sheet of Instructions for Giving Test.)

1. Add
$$\begin{array}{r} 15m \\ 12m \\ \hline \end{array}$$
Ans.

2. Add
$$\begin{array}{r} 8\ ab \\ -7\ ab \\ -5\ ab \\ +2\ ab \\ \hline \end{array}$$
Ans.

3. Subtract
$$\begin{array}{r} 12\ a \\ 7\ a \\ \hline \end{array}$$
Ans.

4. Subtract
$$\begin{array}{r} -4\ ab \\ 11\ ab \\ \hline \end{array}$$
Ans.

5. Add
$$\begin{array}{r} 3a-8b-6c \\ 5a+7b-3c \\ \hline \end{array}$$
Ans.

6. Subtract
$$\begin{array}{r} 15a^2-8a-3 \\ 6a^2+7a+2 \\ \hline \end{array}$$
Ans.

7. Add
$7a-6a^2+10$ and a^2+6a-7.

8. Subtract
$x+xy-3y$ from $6x-3xy+7y$.

9. Collect Terms
$a^2+8a+7a^2+x+7+9x+4+3a=$

10. Collect Terms
$2x-xy+3y-3x+2xy+7y+8=$

Note.—Test sheets as reproduced are reduced in size. Actual test sheets are 8½x11 inches each.

Series A
Test II

Multi-
plication

Douglass
Algebra
Tests

STANDARD DIAGNOSTIC TESTS FOR ELEMENTARY ALGEBRA

DEVISED BY H. R. DOUGLASS

Prob. 1—1.7
Prob. 2—2.7
Prob. 3—2.9
Prob. 4—3.2
Prob. 5—3.6
Prob. 6—3.3
Prob. 7—3.9
Prob. 8—4.6
Prob. 9—5.1
Prob. 10—6.4

Score

Name of Pupil .... Age........... Grade........... Date................

City .... Building.................. Teacher.........................

MULTIPLICATION

1. Multiply
$9m$
2

2. Multiply
$4x^3$
$3x^2$

3. Multiply
$5ab$
$-2a^2$

4. Multiply
$+3ay$
$-6a^2y$

5. Multiply
$4a-3b$
$2ab$

6. Multiply
$4a^2-2x$
$-3x^2$

7. Multiply
$8x-3y$
$4x+2y$

8. Multiply
$7a^2-3x$
$-4ax^2+2$

9. Multiply
$3a^2bc+5b^3cd$
$-4ax^2+2$

10. Multiply
$7by^2z-4a^2cx^2+9ab^2y$
$9byz^2+8a^2bc^3$

Series A
Test III

Division

Douglass
Algebra
Tests

STANDARD DIAGNOSTIC TESTS FOR ELEMENTARY ALGEBRA

DEVISED BY H. R. DOUGLASS

Prob. 1—1.1
Prob. 2—2.3
Prob. 3—2.7
Prob. 4—2.6
Prob. 5—2.9
Prob. 6—2.9
Prob. 7—3.3
Prob. 8—3.2
Prob. 9—3.5
Prob. 10—3.4

Score

Name of Pupil .... Age............ Grade............ Date.................

City .... Building.................. Teacher...........................

DIVISION

1. Divide $12a^4$ by $2a^3$. Ans. =
2. Divide $16x^3$ by $-4x^2$. Ans. =
3. Divide $-18x^3y$ by $2xy$. Ans. =
4. Divide $-16x^9+28x^6-24x^3+8x$ by $4x$. Ans. =
5. Divide $20a^3-15a^2-5a$ by -5. Ans. =
6. Divide $14x^3-28x^2+21x$ by $-7x$. Ans. =
7. Divide $22a^2b^3-16a^3b+8a^2b^4$ by $-2ab$. Ans. =
8. Divide $36a^3b+6a^2b^2-12ab^3+18ab^4$ by $-6ab$. Ans. =
9. Divide $6a^3-18a-11a^2+20$ by $2a-5$.
10. Divide $r^3-19r+84-6r^2$ by $r-7$.

Series A
Test IV

Solution of
Simple
Equations

Douglass
Algebra
Tests

STANDARD DIAGNOSTIC TESTS FOR ELEMENTARY ALGEBRA

DEVISED BY H. R. DOUGLASS

Prob. 1—2.0
Prob. 2—1.8
Prob. 3—3.1
Prob. 4—4.0
Prob. 5—4.5
Prob. 6—3.6
Prob. 7—5.9
Prob. 8—5.7
Prob. 9—6.0
Prob. 10—6.0

Score

Name of Pupil .... Age............ Grade............ Date.................

City .... Building.................. Teacher..........................

SOLUTION OF SIMPLE EQUATIONS

1. Solve for x
   $4x=12.$

2. Solve for y
   $5y=20.$

3. Solve for a
   $4a-3=17.$

4. Solve for b
   $5b+6=18.$

5. Solve for r
   $5r-7=63-3r.$

6. Solve for b
   $3b-6=14-b.$

7. Solve for y
   $\frac{2y}{3}-\frac{3y}{4}-\frac{y}{6}=10.$

8. Solve for a
   $\frac{6a}{7}+\frac{10a}{14}-a=4.$

9. Solve for x
   $\frac{2x}{3}+8=\frac{3x}{2}+\frac{x}{6}+14.$

10. Solve for x
    $\frac{3x}{5}-\frac{x}{2}+\frac{7x}{10}=1+\frac{2x}{2}.$

EXISTING ALGEBRA SCALES AND TESTS

1. Childs, H. G. "Indiana Algebra Tests." Bureau of Co-operation Research, Indiana University, Bloomington, Indiana. A series of twelve tests which are an elaboration of the Monroe Standard Research Tests.

2. Coleman, W. H. "Scale for Testing Ability in Algebra." Superintendent W. H. Coleman, Crawford, Nebraska.

3. Hotz, H. G. "First Year Algebra Scales." Series A and Series B., Bureau of Publications, Teachers' College, Columbia University, New York City. Series B is not recommended. Series A comprises five time tests of graded problems in the fundamentals. Better than the Monroe, Childs or Rugg-Clark tests for diagnosis.

4. Monroe, Walter S. "Standard Research Tests in Algebra." Kansas State Normal School, Emporia, Kansas. A series of six time tests, five for the five fundamental operations involved in solving simple fractional equations and the other for the solution of such equations. Worth little for diagnosis and not exceptionally well adapted to a measurement of the processes by reason of selection of problem material.

5. Rogers, Anna L. "Rogers Mathematical Diagnosis Tests." Published by Teachers' College, Columbia University, New York City. One of a sextet is testing Algebraic Computations and consists of 16 problems of various types testing various algebraic abilities. Of little value for classroom teacher or for supervisory purposes.

6. Rugg, H. O. and Clark, J. R. "Standard Tests for First Year Algebra." May be secured from the authors, School of Education, University of Chicago. A series of 16 time tests constructed on the cycle plan of design. Problems of general equal difficulty, though of same variety of type. Better than the Monroe tests for diagnosis.

7. Stromquist, C. E. "Preliminary Algebra Tests." Published by the author, University of Wyoming, Laramie, Wyoming. A series of seven time tests, constructed of a varying number of problems of apparent equal difficulty purposed to test the fundamentals.

8. Thorndike, E. L. "An Experiment in Grading Problems in Algebra." Mathematics Teacher, Vol. 6 (1914) pp. 123-134.

COPY OF QUESTIONNAIRE

Dear Sir:

In connection with an investigation being made, we are trying to obtain opinions from leading university, college and secondary school teachers of mathematics as to what constitutes the fundamentals of algebra. By the term fundamentals we mean to designate those abstract algebraic processes corresponding to addition, subtraction, multiplication and division—commonly accepted as the four fundamentals of arithmetic—those primary formal processes upon which the large part of algebraic manipulation depends, confining yourself to algebra as it is usually taught in the first year of secondary schools.

Below is a list of such processes. Place a check after those which in your opinion constitute the most elementary and important fundamentals. In case you find that there is little choice as to where to stop, make your line of demarcation at the point where there seems the widest difference between the importance of two processes. In general it is expected that one would check from five or six to ten or a dozen such. Feel free to add other processes that you consider fundamental if this list does not contain such.

Collection of terms.
Division.
Multiplication.
Clearing of fractions.
Transposition.
Exponential manipulation.
Solution of simultaneous linear equations of two or three unknowns.
Solution of simple equation.
Expansion of squares and cubes of binomials.
Factoring of type forms.
Solution of simpler quadratics.
Handling of radicals.
Graphing and solution by graph of linear equations and simple quadratics.
Ratio and proportion.

Sincerely,
H. R. DOUGLASS.

LIST OF ALGEBRA TEXTS FROM WHICH PROBLEMS WERE SELECTED

Breslich—First Year General Mathematics—University of Chicago Press, 1913.
Durrell—School Algebra—Chas. E. Merrill Company, 1914.
Fite—First Course in Algebra. D. C. Heath & Company, 1914.
Godfrey and Siddons—Elementary Algebra. Cambridge Press, 1913.
Hawkes, Luby and Teuton—First Year in Algebra. Ginn & Co., 1910.
Hedrick—First Year in Algebra. American Book Company, 1913.
Long and Brenke—Correlated Mathematics. The Century Company, 1916.
Milne—Standard Algebra. American Book Company, 1914.
Monroe and Ames—First Year of General Mathematics. Unpublished.
Rawlins—Lippincott's Elementary Algebra. J. B. Lippincott and Company, 1901.
Schultze—Elementary Algebra. The Macmillan Company, 1906.
Slaught and Lennes—First Principles of Algebra. Allyn and Bacon, 1912.
Stone-Millis—Essentials of Algebra. Benj. H. Sanborn and Co., 1911.
Wells and Hart—First Year Algebra. D. C. Heath and Company, 1912.
Williams and Kempthorne—First Courses in Algebra. Lyons and Carnahan, 1913.

BIBLIOGRAPHY

Broone, M., Spett, A. and Myers, G. "Speed vs. Accuracy in Learning." School and Society, Vol. VIII, 1918, p. 687. An experiment to determine the relation of speed to accuracy in learning.

Childs, Herbert G. "The Measurement of Achievement in Algebra." Third Conference on Educational Measurements, University of Indiana Extension Bulletin No. II, 1917, pp. 171-183.

Dalman, Murray A. "A Series of Calibrated Objective Tests in First Year Algebra," Journal of Educational Research, Vol. I, 1920, pp. 47-63. An account of the use and results of a specially devised series of tests for purposes of individual diagnosis and motivation of first year algebra work.

Hotz, Herbert G. "First Year Algebra Scales." Teachers College, Columbia University. Contributions to Education No. 90, 1918. A very readable account of the derivation, uses and administration of the Hotz First Year Algebra Scales.

Monroe, Walter S. "A Test of the Attainment of First Year High School Students in Algebra." School Review, Vol. XXIII, 1917, pp. 159-171. A report of the results of giving the Monroe Research Algebra Tests in a number of Kansas high schools, with tabulated results and correlations.

Monroe, Walter S. "Measurement of Certain Algebraic Abilities," School and Society, Vol. I, 1915, pp. 393-95. An account of the construction of the Monroe Standard Research Tests for Algebra.

Rogers, Agnes L. "Tests of Mathematical Ability—their Scope and Significance." Mathematics Teacher, Vol. XV, 1919, No. 4. A very clear and accurate statement of the principles underlying various types of mathematics tests and briefly the possibilities of the same.

Rugg, H. O. and Clark, J. R. "Standardized Tests and the Improvement of Teaching in First Year Algebra." School Review, Vol. XXV, 1917, pp. 113-132;196-213. A very lucid statement of the general principles involved in constructing time tests for first year algebra, especially that of the cycle plan of design, and an account of the derivation of the Rugg-Clark Tests with some possibilities of such tests in the improvement of teaching the subject. Other articles of lesser interest appear on pages 345 and 546 of the same volume and on page 37 of volume 24.

Rugg, H. O. and Clark, J. R. "Construction of Standardized Tests." Chapter IV of Supplementary Educational Monograph, Vol. II, No. 1, University of Chicago Press. "Scientific Method in the Reconstruction of Ninth Grade Mathematics." A statement of the needs of standard tests in algebra; a differentiation of "rate" and "development" tests; the principles of design of standard tests in mathematics; a criticism of the Monroe tests and a meagre account of the Rugg-Clark Tests.

Rogers, Agnes L. "Experimental Tests of Mathematical Ability and Their Prognastic Value." Teachers' College, Columbia University, Contributors to Education, No. 89, 1918. A report of results and conclusions from an experimental study of the prognostic value of certain mathematical tests as demonstrated by the relation of results made by several hundred pupils on such tests and the school marks of the same pupils.

Thorndike, E. L. "An Experiment in Grading Problems in Algebra." Mathematics Teacher, Vol. VI, 1914, pp. 123-134. An account of the Thorndike Algebra Scale and the results from giving it to a limited number of high school students.

Thorndike, E. L. "Relation Between Speed and Accuracy." Journal of Educational Psychology, Vol. V, 1916, pp. 537-543. Experimental determination of the relation of accuracy in adding to various rates of speed.

Trabue, Marion Rex. Completion-Test Language Scales. Teachers' College, Columbia University, Contributors to Education, No. 77, 1916. An account of the method of derivation and standardization of the Trabue scales. The method of weighting, method of determining of the zero point, and the table of P. E. equivalents are given.

THE TRIGONIAE FROM THE PACIFIC COAST OF NORTH AMERICA

BY

EARL L. PACKARD

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1921

1.

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          Trigonia naviformis Hyatt

      Group Clavellatæ Agassiz
          Trigonia charlottensis, n. sp.
          Trigonia dawsoni Whiteaves
          Trigonia devexa Eichwald
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      Group Undulatæ Agassiz
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The Trigoniae from the Pacific Coast of North America

INTRODUCTION

The genus *Trigonia* is easily recognized and is very characteristic of the Jurassic and Cretaceous West Coast faunas. The world wide distribution and the large number of species having highly ornamented shells, have attracted much attention to this group and thus several monographic studies of the genus have been published. As yet no attempt has been made to include the West Coast species of North America in such works, although the Japanese forms have been carefully studied and reported upon by Yehara.[1]

The several unnamed species of *Trigonia* early obtained by Professor Thomas Condon and the large collections recently obtained from the Cretaceous of the Bear Creek Valley area of Jackson County, Oregon, made possible by a grant from the California Academy of Sciences, suggested this study of the West Coast species. Through the courtesy of the department of Paleontology of the University of California, the California Academy of Sciences, the United States Geological Survey, and Dr. C. F. Newcombe of Victoria, British Columbia, much additional material has been available for study.

The types or typical specimens of several of the previously described species have been studied and are herein refigured. In the cases where the types have been lost or were not available the original description and figures have served as a basis for certain conclusions. Since these descriptions are widely scattered through the literature they have been quoted and the original figures reproduced.

---

[1] Yehara, Shingo. Science Reports of the Tohoku Imperial University, 2 series Geol. Vol. 2, pp. 36-44, pls. 1-2, 1915.

The types of the new species may be found in the Condon Museum, University of Oregon, except for one which is in the Newcombe collection, Victoria, British Columbia, and one belonging to the Department of Paleontology, University of California.

The writer wishes to acknowledge his indebtednes to Dr. Bruce L. Clark, of the Department of Palæontology, University of California, for the opportunity of examining Californian and Japanese material belonging to the department· and to express his gratitude to Dr. Barton W. Evermann, director of the California Academy of Sciences, for the privilege of describing material belonging to that institution. He is likewise indebted to Dr. C. F. Newcombe for the loan of his valuable collection and for the inspiration engendered by his enthusiasm, and to Dr. F. H. McLearn, of the Canadian Geological Survey, for courtesies extended. He is especially indebted to Dr. T. W. Stanton and Dr. J. Perrin Smith, for their friendly criticism of this paper as well as for the loan of several specimens.

FAUNAL RELATIONSHIPS

The various monographic papers dealing with the Trigoniidæ have largely followed the grouping scheme first proposed by Agassiz,[2] and amended by Lycett,[3] Stoliczka,[4] and others. The classification is still essentially as first proposed, but Lycett's later work has been closely followed in this paper.

The generic characters of the genus *Trigonia* are fairly constant through a large number of species, although superficially the forms differ markedly. The differences of sculpture serve as a means of arbitrarily dividing the genus into at least eight groups, some of which are possibly polyphyletic. Nevertheless, they are convenient subdivisions and presumably in most cases the species of a group are genetically related. These groups are herein defined and a figure of the European type of several of the groups is given.

These definitions include a few terms of special significance in the descriptions of the members of this genus which may need explanation. It is frequently convenient to refer to a ridge, that in some species extends from the beak to the posterior extremity as the *marginal carina.* Another ridge, the *inner carina,* separates the escutcheon from the remaining portion of the dorsal area. Occasionally this area is divided by a *median carina* or *median furrow.* The ribs or rows of pustules occurring on the area or escutcheon are commonly called *costellae,* whereas those on the disk are known as *costae.*

---

[2] Agassiz, L. Etudes critique sur les Mollusques, Memoire sur les Trigonies, 1840.
[3] Lycett, John. A monograph of the British Fossil Trigoniæ. 1872-79.
[4] Stoliczka, F. Palæontologia Indica, Cretaceous fauna of Southern India, Vol 3, pp. 314-318. 1871.

Seven of the eight recognized groups into which the genus *Trigonia* has been divided are represented by West Coast species. Two of these groups, the Undulatæ and Costatæ are restricted to the Jurassic, and one, the Quadratæ, is known only from the Cretaceous.

The oldest known West Coast *Trigonia* fauna occurs in the Hardgrave sandstone (Lower Jurassic) of Taylorsville, Shasta County, California. The two species of that fauna are referred to the Costatæ and the Undulatæ groups elsewhere typical of the Jurassic. One of these, according to Hyatt, is related to the European species, *T. costata* Sowerby, a form having a wide geographic range in Europe and occurring in the Jurassic, of Spiti Pass, Northern India, and the Cutch in Southern India. A near relative of this same species, *T. moorei* Lycett, occurs in the Australian Jurassic. The second species from the Taylorsville region is thought to have affinities with the European Inferior Oolite species, *T. costatula* Lycett.

The Mormon sandstone of the Taylorsville region has yielded a younger fauna which includes representatives of the Costatæ and the Clavellatæ. The two species of Costatæ have been referred to European species from the Oolite beds. The other Mormon sandstone species was likewise considered as having affinities with an old world species.

A Taylorsville *Trigonia* fauna in the Bicknell sandstone overlying the Mormon sandstone has yielded several species belonging to the Glabræ, Scabræ and Scaphoideæ and an unnamed specimen probably belonging to the Undulatæ. These species also have affinities with European forms. *T. obliqua* Hyatt resembles *T. michelloti* de Loriol; *T. plumasensis* Hyatt is like *T. lusitanica* Sharp; and *T. naviformis* Hyatt is similar to *T. navis* Lamarck. A small species *T. pandicosta* Meek occurs in the Jurassic of Genessee Valley, Plumas County.

Three Jurassic species are known from Alaska. The fauna of the Tuxedni sandstone of Cook Inlet includes *T. doroschini* Eichwald and *T. devexa* Eichwald and *T. dawsoni* Whiteaves. The Yakoun formation of the Queen Charlotte Islands contains *T.*

dawsoni Whiteaves. These three northern forms represent the Clavellatæ and Undulatæ groups.

Although fragments of specimens of *Trigonia* have been reported from other West Coast Jurassic localities, including the Mariposa formation of California, determinable specimens are unknown between the close of the epoch of the Bicknell sandstone of the Taylorsville Jurassic and the Horsetown stage of the Cretaceous.

The oldest West Coast Cretaceous fauna including specimens of *Trigonia* is that of the uppermost Horsetown of the type section in California and the supposed Horsetown of Riddles, Douglas County, Oregon. These representatives, *T. leana* Gabb, and T. *aequicostata* Gabb, belonging to the Quadratæ and the Scabræ, probably both range upward into the Chico, the former being very common in the lower Chico.

The *Trigonia* fauna of the Chico or its probable equivalents, is a large one comprising the following West Coast species:

- Scaphoideæ
  - T. diversicostata Whiteaves
- Scabræ
  - T. æquicostata Gabb
  - T. columbiana, n. sp.
  - T. deschutesensis, n. sp.
  - T. evansana Meek
  - T. evansana var. oregana, n. var.
  - T. flexicostata Burwash
  - T. inezana, n. sp.
  - T. maudensis Whiteaves
  - T. newcombei, n. sp.
- Clavellatæ
  - T. charlottensis, n. sp.
- Glabræ
  - T. californiana, n. sp.
  - T. jacksonensis, n. sp.
  - T. tryoniana Gabb
- Quadratæ
  - T. fitchi, n. sp.
  - T. leana Gabb
  - T. leana var. whiteavesi, n. var.

These seventeen species and varieties belong to five groups, two of which, the Glabræ and the Quadratæ are not represented in the Jurassic. A third group, the Scabræ, although containing the largest number of Cretaceous species also includes one Jurassic form. The nine species and varieties of the Scabræ belong to two distinct sections paralleling the European groups characterized by *T. pennata* and *T. aliformis*. The latter group includes five West Coast Chico Cretaceous forms, the best known of which is *T. evansana*.

This species described from British Columbia apparently represents a more specialized stage in the development of the broad unornamented area than that of the more typically southern species *T. inezana.* This specialization is still farther advanced in the variety *oregana,* a condition paralleled or equalled by that of the Japanese species *T. hokkaidoana* Yehara. Another form *T. deschutesensis,* as yet recognized only from the Oregon Chico embayment, may represent a local species. The pennatæ division also includes six species, of which *T. maudensis* stands as a type. Except for *T. aequicostata,* concerning which little is known, the members of this group are known only from the Queen Charlotte Islands. The new species *T. newcombei,* characteristic of the Haida Cretaceous, is similar to a form known from the Upper Cretaceous of Japan. Such a similarity suggests a close faunal connection and indicates an Oriental derivation of many of the West Coast Chico species of *Trigonia.*

The species *T. tryoniana* and *T. californiana,* both members of the Glabræ, are closely allied, the latter possibly being derived from the former by a reduction of the costæ. Unfortunately the known geologic range of the two is so nearly the same that such a suggestion cannot now be adequately tested.

The Quadratæ includes the extremely variable species *T· leana* which is very characteristic of the Bear Creek Valley Cretaceous area of Oregon and of the Queen Charlotte Islands. A highly ornate variety from the Santa Ynez Mountains, California, represents one extreme as regards the conspicuousness of the costæ whereas the typical form so abundant at Medford, Oregon, may be considered the opposite extreme, with an intermediate type very common in the more northern localities.

The lack of Upper Jurassic and Lower Cretaceous *Trigonia* faunas precludes the possibility of working out the phylogenies of the Chico species. None of the later forms are apparently closely allied to the earlier species, there being only two instances where the same group is represented in both periods. The affinities of the Lower Jurassic species with Asiatic and European species suggest migrations in the early Jurassic into this province, possibly followed by local differentiation. A second migration, presumably from the Orient, apparently took place some time after the first wave of migration had brought in the Indio-Pacific fauna at the beginning of the Horsetown Cretaceous.

GEOLOGIC AND GEOGRAPHIC RANGE

The following table gives the geographic and approximate geologic range of the West Coast species of *Trigonia:*

TABLE 1

	Geologic Range						Jurassic				Cretaceous								
	Jurassic			Cretaceous			California			Alaska and B. C.	California			Oregon		Washington	British Columbia		Alaska
SPECIES	Hardgrave	Mormon	Bicknell	Knoxville	Horsetown	Chico	Hardgrave	Mormon	Bicknell	Jurassic	So. California	Cen. California	Northern	Crooked Riv. Ar.	Bear Creek Ar.	San Juan Co.	Vancouver Is.	Queen Charlotte Is.	Cook Inlet
Schaphoideæ—																			
Trigonia naviformis Hyatt			*						*										
Trigonia diversicostata Whiteaves						*												*	
Clavellatæ—																			
Trigonia charlottensis, n. sp.						*												*	
Trigonia dawsoni Whiteaves		?						?		*									
Trigonia devexa Eichwald		?								*									
Trigonia aff. formosa Lycett	*						*												
Undulatæ—																			
Trigonia aff. costatula Lycett	*						*												
Trigonia doroschini Eichwald		?								*									
Trigonia obliqua Hyatt			*						*										
Trigonia pandicosta Meek		?						?											
Glabræ—																			
Trigonia californiana, n. sp.						*							*						
Trigonia jacksonensis, n. sp.						*									*				
Trigonia tryoniana Gabb					?	*						*	*	?			*		
Quadratæ—																			
Trigonia fitchi, n. sp.						*									*				
Trigonia leana Gabb					?	*						*	*						
Trigonia leana var. whiteavesi, n. var.						*						*		?				*	
Scabræ—																			
Trigonia columiana, n. sp.						*												*	
Trigonia deschutesensis, n. sp.						*													
Trigonia evansana Meek					*	*					?	*	*						
Trigonia evansana, var. oregana, n. var.						*								*					
Trigonia inezana, n. sp.						*						*							
Trigonia æquicostata Gabb					*	*							*		*				
Trigonia condoni, n. sp.						*									*				
Trigonia flexicostata Burwash						*												*	
Trigonia maudensis Whiteaves						*												*	
Trigonia newcombei, n. sp.						*												*	
Trigonia plumasensis Hyatt			*						*										
Costatae—																			
Trigonia aff. costata Sowerby	*						*												
Trigonia aff. hemispherica Lycett		*						*											

DESCRIPTION OF SPECIES

FAMILY: TRIGONIIDÆ LAMARCK

Shell equivalve, nacreous within; hinge with 2-3 lamellar interlocking teeth; mantle lobes free, capable of serving as a functional siphon; pallial line simple; foot angulated, adapted for leaping.

SUBFAMILY:.. TRIGONINÆ

GENUS: TRIGONIA BRUGIERE

Type: *Trigonia nodulosa* Lamarck

Shell equivalve, inequilateral, generally subtrigonal in outline; umbones moderately inflated, anterior; beaks small, opisthogyrate; escutcheon generally well defined; posterior area frequently limited by a carina extending from the umbones to the posterior basal margin; lunule absent; sculpture on escutcheon and posterior area generally discrepant with that of the medial and anterior portions of the shell; dentition consisting of heavy, divergent, striated, lamelliform cardinals; two in the right valve and three in the left; those of the left valve consisting of a heavy trigonal, transversely striated, middle cardinal, and two smaller cardinals, the latter being striated on the inner side only. Ligament external, marginal, opisthodetic; adductor scars strong, the posterior being frequently buttressed; pallial line indistinct, distant, entire.

GROUP: SCAPHOIDEÆ Agassiz

Type species: *Trigonia navis* Lamarck
Plate 1, Figure 9

Triangular species, having a truncated anterior extremity; area generally smooth, occasionally possessing an indistinct inner and marginal carina. Costæ forming two series, those of the posterior series extending from the marginal carina perpendicularly to the basal region, the anterior series consisting of a smaller number of short costæ nearly at right angles to the posterior series, divisional siphonal ridge lacking.

Geologic range: Jurassic and Cretaceous

This group is represented on the West Coast of NorthAmerica by the following species:

- Jurassic
    - Trigonia naviformis Hyatt
- Cretaceous
    - Trigonia diversicostata Whiteaves

TRIGONIA DIVERSICOSTATA WHITEAVES

Plate 3, Figure 4

Trigonia diversicostata Whiteaves, Mesozoic Fossils, Vol. 1, p. 68, pl. 10, fig. 1, 1876.

Whiteaves originally described this form as follows:

> Shell moderately inflated, elongated, scaphoid or subarcuate, very inequilateral; anterior end short and rounded; posterior side produced, cuspidate and bluntly pointed above. Beaks large, projecting, recurved, anterior, nearly terminal. Lunule none; posterior area (of the two united valves) broadly ovate lancelate with a rounded margin. Hinge border, behind the beaks, straight or slightly concave, sometimes with a very gentle downward inclination, which becomes a little more decided at the tip of the beaked posterior extremity. Ventral margin broadly rounded, but the upward curve is always greatest behind. The short anterior end is always much wider than the posterior extremity, and the margin of the latter is convex below and almost straight above. As measured in the centre, behind the beaks, the height is less than half the length; the thickness or convexity is nearly equal to the height.
>
> Surface boldly ribbed, with a very singular and complex style of costation. At the anterior end the general direction of the ribs is almost horizontal, but near the margin they are curved, and ultimately straighten and trend upwards. In the basal half of the shell, however, they are either undulated or broken up into a series of zigzags. Thirteen or fourteen of these horizontal ribs commence at the margin of the anterior end; then, near the middle of the valves, five or six of them suddenly bend upwards at a sharp angle, and become either transverse, or at length incline a little forwards. About one-half of the ribs which proceed from the anterior end are not continuous, but are distinctly truncated by the upward bend of those which reach to the superior border. This is most obvious in the umbonal region, for on the beaks the first five anterior ribs are cut off, as it were, by the upward bend of the sixth. Below this the anterior costæ seem alternately continuous and interrupted.
>
> Towards the posterior end, the ribs are transverse and cross the valves in a radiating manner, the radii being directed backwards. At their junction with the outer border of the hinge area, these posterior costæ are narrow above and widen symmetrically to the margin below or behind.
>
> The posterior area is ribbed longitudinally; but the costæ are curved and follow its general outline. At first they are very narrow, and attain their maximum width at the point farthest from the beaks. In some specimens the ribs which traverse the valves behind bifurcate with those on the posterior area, and at the extreme tip of the beaked end the direction of both is not far from parallel.
>
> The sculpture of this distinctly characterized species is subject to considerable variation. In one specimen the transverse ribs which proceed from the anterior margin, are bent into a series of zigzags before they take their fiinal upward turn. In another distorted example the same ribs traverse fully two-thirds of the shell before they bend upwards, and their angles lie in the direction of a line drawn obliquely from the beaks to the base of the posterior end. In the majority, the longitudinal and transverse ribs occupy each about one-half of the surface, and the angles of those which so suddenly alter their course are placed in the direction of an obliquely concave line which might be drawn from the beaks to a little behind the middle of the base. Again, in one instance the costæ on the posterior area bifurcate distinctly with the transverse ribs on the main body of the shell, in other examples the latter are truncated by the former. In all cases, however, the ribs in front, though they trend upwards, and their course is more or less broken, are nearly longitudinal; on the posterior area they are decidedly so, while on the beaked posterior end and on the hinder part of the umbonal region they are transversely radiating.

Length, 44.6 mm.; height, 21.1 mm.; diameter, 19 mm.; according to the author of the species.

The type specimen came from the Haida Cretaceous of Bear Skin Bay, Skidgate Inlet, Queen Charlotte Islands. The specimen figured in this paper is from a photograph of the type, now in the collections of the Geological Survey of Canada, kindly furnished by Mr. F. H. McLearn.

Whiteaves referred this form to the Scaphoideæ group, apparently upon the basis of the arrangement of the costæ. This species, however, does not fully meet the requirements of the original definition of that group since the escutcheon is ornamented by strongly developed longitudinal ribs and since it lacks a well-defined posterior dorsal area. An examination of a photograph of the type specimen suggests the possibility that this species is allied to *T. newcombei* and *T. maudensis,* which undoubtedly belong to the pennatæ subgroup of the Scabræ. The definition of that group calls for transverse costellæ, which condition is satisfied by the ornamentation of those two species. *T. diversicostata,* on the other hand, has strong radiating rounded ribs that are distinctly longitudinal, curving slightly to conform with the marginal carinæ. These obviously cannot be considered as transverse and therefore this species cannot be included in the Scabræ group as it is now understood. It appears, however, to meet the requirements of the Scaphoideæ group more closely than those of the other division, so that it is here tentatively included although it may be necessary ultimately either to set up another division for this form or to revise and enlarge one of these groups so as to include it.

Whiteaves reports this species from Bear Skin Bay, Skidegate Inlet, and questionably from east end of Maud Island and near Yakoun Lake on Rennell Sound Trail, Queen Charlotte Island, B. C.

Horizon: Upper Cretaceous, Haida formation.

TRIGONIA NAVIFORMIS HYATT
Plate 2, Figure 1

Trigonia naviformis Hyatt, Bull. Geol. Soc. Am. Vol. 3, p. 407, 1882.

Only the preliminary description of this species has ever been published. The following description is based upon casts from the type moulds kindly furnished by Dr. T. W. Stanton, of the U. S. Geological Survey:

Shell large, elongate; anterior dorsal margin sloping downwards and backwards to the broadly rounded base; posterior extremity long and bluntly rounded; dorsal posterior margin nearly straight; posterior dorsal area limited by an indistinct carina bearing a few low postules near the posterior end; escutcheon apparently undeveloped; umbones tumid, situated so far anteriorly that a vertical line dropped from the beak passes in front of the anterior margin of the shell. Disk ornamented by two distinct sets of costæ, the posterior series of ribs extend vertically or obliquely from the dorsal area to the base; near the dorsal area they are low indistinct ridges, but become higher and more conspicuously nodose from the middle portion of the disk to the base, the eighth to twelfth rib from the posterior end being especially nodose; the anterior series of costæ are oblique to the first, consisting of eight short ribs extending from the anterior margin in a slight curve to the indistinct umbonal ridge, where each terminates in a very conspicuous and elongated pustule; interspaces wide, marked by fine growth lines; dorsal area without ornamentation except for coarse growth lines. Dentition and interior unknown, the lectotype being an external mold of the left valve, made from type material determined by Hyatt. Length of lectotype 95mm.; height, 85 mm.; convexity about 18 mm.

Lectotype number 32478 U. S. National Museum. Obtained from the Bicknell sandstone, Mount Jura, Taylorsville, California.

Hyatt's name signifies the affinities of this species with the European species *T. navis* Lamarck the typical species of the Scaphoideæ group. It is readily separable from that species upon the basis of its more ridge-like costæ, and the peculiar tuberculated posterior termination of the short anterior costæ. These general similarities between the two species clearly indicate the group position of the California specimen. Its distinctive shape precludes possible confusion with other known West Coast species.

Horizon: Middle Jurassic, Bicknell sandstone.

GROUP: CLAVELLATÆ AGASSIZ

Example: *Trigonia clavellata* Parkinson
Plate 1, Figure 2

Triangular species; area bounded by tuberculated carinæ and usually divided by a mesial carina; escutcheon plain, depressed; costæ tuberculated, arranged in concentric or oblique rows; interior of valve with a divisional siphonal ridge.

Geologic range: Jurassic and Cretaceous.

This group is represented by the following West Coast species:

- Jurassic
  - Trigonia aff. formosa Lycett
  - Trigonia dawsoni Whiteaves
  - Trigonia devexa Eichwald
- Cretaceous
  - Trigonia charlottensis, n. sp.

TRIGONIA CHARLOTTENSIS, N. SP.

Plate 3, Figure 1

Shell, large subquadrate, moderately inflated; length about twice the height; beaks nearly terminal; anterior end evenly rounded; ventral margin nearly straight in front, curving upwards to meet the bluntly truncated posterior end; posterior dorsal margin concave; posterior dorsal area limited by marginal carinæ forming the conspicuous umbonal angles; escutcheon bordered by a carina bearing inconspicuous pustules. Surface ornamented by about fifteen heavy nodose ribs arising at the marginal carinæ and curving downwards and forwards, the hindermost five being more nearly straight than those farther forward; near the anterior basal margin the irregularly nodose costæ show a tendency to break up. Carinæ conspicuous, having minute pustules, which are obscured by the growth lines which form the only apparent ornamentation of the escutcheon and area. Hinge and interior of the type unknown. Length of type, 77 mm.; height, 60 mm.; diameter, 32 mm.

Cotype from University of Oregon locality number 106, Maude Island. The type belongs to Dr. C. F. Newcombe* Victoria, B.C., who collected it from the north side of Maude Island, Queen Charlotte Islands, B. C.

This species is represented by several specimens collected by the writer on the north shore of Maude Island, Skidegate Inlet and by excellent specimens in the Newcombe collection. These show but relatively slight form variation, but the costation in some of the specimens is slightly more nodose than that of the type. The hinge is heavy, the cardinals being long. Several of the specimens also show a conspicuous divisional siphonal ridge.

This is the only Cretaceous representative of this group known from this province. It differs from *T. dawsoni,* its most closely allied species in its larger size, coarser ribbing, and straighter costæ.

Horizon: Upper Cretaceous, Haida formation.

TRIGONIA DAWSONI WHITEAVES

Plate 4, Figure, 2

Trigonia dawsoni Whiteaves, Geol. Surv. Canada, Rep. Progs. 1876-77, p. 154. Mesozoic Fossils, Vol. 1, p. 231, pl. 31, fig. 1 and 1a, 1876. Cont. Canadian Palæont. Vol. 1, p. 167, 1889.

Trigonia intermedia (Fahrenkohl), Whiteaves. Mesozoic Fossils, Vol. 1, p. 262, 1876.

Whiteaves described this species from Queen Charlotte Islands as follows:

> Shell gently convex; outline ovately-subtrigonal; anterior end very short, broadly rounded, as is also the ventral margin; beaks elevated, recurved, anterior, subterminal; hinge line sloping concavely downwards behind the beaks; extremity of the somewhat elongated posterior end truncated rather obliquely. Surface of the main body of the shell marked by about twelve curved, nodulous costæ, all of which commence at the margin of the posterior area. The five nearest the beaks curve downwards, and terminate at the anterior end. The middle ones, though curved, are nearly transverse, and end at the center of the ventral margin, while the last three incline decidedly backwards. The posterior area is marked either by crowded, transverse, regularly arranged and continuously raised striæ, or by coarse, irregular and broken up or angularly bent, short, transverse folds.

Length of type, 55 mm.; height 42 mm., as measured on the original figure.

The type is now in the collections of the Canadian Geological Survey. The type locality is Iltasyouco River, B. C.

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*This specimen has recently been presented to the Condon Museum.

Whiteaves recognized certain affinities between this supposed Cretaceous species and the Jurassic form *T. montanaensis* Meek. Later he referred it to the Russian Newcomian species *T. intermedia* Fahrenkohl, but after reconsideration abandoned that view upon obtaining better preserved material which differed from the European species in being larger, having larger nodes and in the type of sculpture of the broad posterior area.

Stanton and Martin[5] tentatively identified specimens from the Jurassic rocks of Alaska, which have since been named the Tuxedni sandstones, as *T. dawsoni.*

To this increasing evidence of the Jurassic age of *T. dawsoni* was added the discovery by MacKenzie[6] of the unconformable relationships of the rocks now known as the Yakoun formation and the Haida Cretaceous, the former being Division D of Dawson.[7] There is therefore little doubt of the presence of Jurassic rocks near Alliford Bay, a typical locality of this species. Also found at Sigut Lake, B. C.

The prominent carinæ and the nodose character of the costæ readily distinguish this species from other known West Cast representatives of this group.

Horizon: Jurassic, Yakoun formation.

TRIGONIA DEVEXA EICHWALD

Trigonia devexa Eichwald, Bemerkungen über die Halbinsel Mangischlak und die Aleutischen Inseln. St. Petersburg 1871, p. 183, pl. 17, figs.5 and 6. Stanton and Martin. Bull. Geol. Soc. Am. Vol. 16, p. 398, 1905.

This was originally described as follows:

> Die Muschel is fast halbmondfôrmig, länger, als hoch, und der lange scharfe Oberrand etwas ausgebuchtet, vorzüglich in grossen Exemplaren; der Vorderrand ist kurz, stark abschüssig; die Oberläche ist mit starken, senkrechten, knotigen und weit abstehenden Rippen bedeckt.

The specimens listed by Stanton and Martin came from Iniskin Bay, Cook Inlet, Alaska. This species has not been studied since material was not available.

Horizon: Middle Jurassic, Tuxedni sandstone.

TRIGONIA AFF. FORMOSA LYCETT

Trigonia, n. sp. Hyatt, Bull. Geol. Soc Am. Vol. 3, p. 405, 1892.

Hyatt lists a species from the Hardgrave, Lower Jurassic of Taylorsville, California, as *Trigonia,* n. sp. and compares it with *T. formosa* Lycett. The material upon which the determination was made has not been studied. Such a species would belong to the Clavellatæ.

Horizon: Lower Jurassic, Hardgrave sandstone.

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[5] Stanton, T. W. and Martin G. C. Mesozoic section on Cook Inlet and Alaska Peninsula. Bull. Geol, Soc. Am., Vol. 16, p. 402, 1905.

[6] MacKenzie, S. D. Geology of Graham Island, British Columbia, Mem. 88, Geol. Surv. Canada, p. 47. 1916.

[7] Dawson, G. M. Geol. Surv. Canada, Ann. Report, 1878-79, p. B—239B.

GROUP: UNDULATÆ AGASSIZ

Type species: *Trigonia litterata* Young and Bird.
Plate 1, Figure 5

Triangular species resembling the Clavellatæ except that the generally tuberculated costæ bend upwards abruptly near the middle of the shell. Area narrow, carinæ inconspicuous, mesial furrow present.

Geologic range: Jurassic

This group is represented within this province by *Trigonia* aff. *costatula* Hyatt, *T. obliqua* Hyatt, *T. pandicosta* Meek, and probably by *T. doroschini* Eichwald.

TRIGONIA AFF. COSTATULA LYCETT

Trigonia n. sp. Hyatt, Bull. Geol. Soc. Am., Vol. 3, p. 402, 1892.

Hyatt lists a species from the Hardgrave, Lower Jurassic of Taylorsville, California, as *Trigonia* n. sp. and compares it with the European form *T. costatula,* a member of the Undulatæ. The specimens are in the United States National Museum but have not been further studied.

Horizon: Lower Jurassic, Hardgrave sandstone.

TRIGONIA DOROSCHINI EICHWALD

Plate 3, Figures 2 and 3

Trigonia doroschini Eichwald, Bemerkungen über die Halbinsel Mangischlak und die Aleutischen Inslen. St. Petersburg, 1871, pp. 180-181, pl. 13, figs. 12, 13 and 14, pl. 14, figs 1, 2, 3, and 4. Stanton and Martin, Bull. Geol. Soc. Am. Vol. 16, p. 396, 1871.

This species was described as follows:

> Testa subtriangularis subinflata, antica parte rotundato-dilatata, postica leniter compresso, attenuata, superficie antice transversim et apprime costata, costis aliis verticalibus, paulloquis, inferiora versus dilatatis, ad transversa descendentibus; area acuto margine medio et profundo recession dorsali, margine prosiliente divisa; fasciis aliis transversis brevibus in serie sitis, approximatis, ac linea intermedia eminente a vertice obortis aream transversim striatam exornantibus.

The dimensions are: Length about 65 mm.; height, 36 mm.

This species was obtained "im schwarzen Neocomkalksteine dei Egge in der Bucht Tukusitmu" in Kenai, Alaska, The location of the type material is unknown. Stanton and Martin referred specimens collected in Iniskin Bay, Cook Inlet, Alaska, to this species.

This species has not been studied therefore the suggestion that the sculpture indicates its affinities with the Undulatæ may be somewhat premature. Judging from the description and cuts, it would not easily be confused with other West Coast Jurassic species, however, it might be confused with a form from the Haida Cretaceous of Maude Island, Skidegate Inlet, Queen Charlotte Islands, B. C., known as *T. flexicostata* Burwash.

Horizon: Middle Jurassic, Tuxedni sandstone.

TRIGONIA OBLIQUA HYATT

Plate 3, Figures 5 and 6

Trigonia obliqua Hyatt, Bull. Geol. Soc. Am., Vol. 3, p. 407, 1892.

Only a preliminary description of this species was given by Hyatt. The following is based upon casts from the type molds kindly furnished by Dr. T. W. Stanton, of the United States Geological Survey.

Shell small, compressed, ovoid, anterior dorsal margin apparently convex, anterior end bluntly rounded, base broadly rounded; posterior extremity broadly curved to the umbonal angle where it changes direction rather abruptly to meet the even, convex, upward curve of the posterior dorsal margin; posterior area limited by a carina, which is sharp and conspicuous near the low, pointed beaks, but flattens out so it is hardly distinguishable near the basal angle. Umbones low, situated slightly anterior of the middle of the shell. Sculpture apparently inconspicuous; anterior margin of the disk possessing numerous ill-defined ridges scarcely distinguishable from incremental lines of growth, which toward the beak are more regular and ridge-like; on the umbone these bend abruptly upward; median and posterior portion of the lectotype lack traces of ornamentation, but it is not certain that this species is unornamented on that portion of the disk. The posterior dorsal area lacks costellæ, but appears to possess an indistinct medial groove, which apparently served to delimit an ill-defined escutcheon.

Another specimen of the type material shows the posterior area to be definitely limited by a distinct umbonal ridge and a mesial groove, which near the beaks changes to a ridge; the entire area is crossed by concentric rounded and slightly wavy growth lines. The disk just anterior to the umbonal ridge is ornamented by faint radial costæ, a condition imperfectly seen at the apex of the umbone where at least three radiating posterior ribs seem to abruptly bend forward with a concave curve upward as is typical of the Undulatæ group. Dentition and interior unknown, the lectotype being an external mold of the right valve. Length of lectotype approximately 60 mm.; height 40 mm.; convexity, 5 mm.

Lectotype number 32479 U. S. National Museum. Type material from the Bicknell sandstone, Mount Jura, Taylorsville, Shasta County, California.

Hyatt considered this species as having affinities with the European form *T. michelotti* de Loriol, but the nodose costæ, and the conspicuous medial carina of that foreign species differs considerably from the fine ridge-like sculpture found on Hyatt's species.

The strong suggestion of upward bending costæ on the umbones and the character of the posterior area of the specimen referred to above, indicates that this species should be grouped with the Undulatæ.

Horizon: Middle Jurassic, Bicknell sandstone.

TRIGONIA PANDICOSTA MEEK
Plate 4, Figure 3

Trigonia pandicosta Meek, Pal. Calif., Vol. 1, p. 48, pl. 8, fig. 7. Meek described this species as follows:

> Shell small, rhombic subquadrate; moderately convex; beaks prominent, oblique, and nearly terminal; anterior side very short, rounding obliquely backwards into the rather short, rounded base; posterior side comparatively broad, compressed, and nearly vertically truncated. Corselet wide, compressed, occupying nearly half the surface of each valve, only marked with distinct, regular thread-like lines of growth, separated from the flanks by a linear ridge extending from the back part of each beak, with a gentle curve, obliquely backwards and downwards to the postero-basal margin. Flanks and anterior side ornamented by six to eight costæ, which extend from the margin of the corselet, first obliquely backwards and downwards, after which they are deflected very abruptly forwards and upwards.

Length of type, 1.3 mm.; height, about 8 mm.; convexity, about 8 mm.

The type was obtained from the Jurassic of Genessee Valley, Plumas County, California. The location of the type is unknown.

This small species, belonging to the Undulate group, has not been studied. Its small size, and coarse ribbing readily separate it from other West Coast species.

Horizon: Jurassic.

GROUP: GLABRÆ AGASSIZ

Type: *Trigonia gibbosa* Sowerby

Shell ovately oblong; area indistinctly limited, generally bipartite but without conspicuous carinæ; anterior costæ generally inconspicuous and close together; wide, unornamented mesial area just anterior to and below the marginal carina; internal siphonal ridge very prominent.

Geologic range: Jurassic and Cretaceous

This group has been divided into two subgroups named after *T. gibbosa* Sowerby, and *T. excentrica* Parkinson (plate 1, figure 8.) The latter lacks an escutcheon.

The following West Coast species belong to the Glabræ, the excentrica subgroup alone being represented.

Cretaceous
- Trigonia californiana, n, sp.
- Trigonia jacksonensis, n. sp.
- Trigonia tryoniana Gabb.

TRIGONIA CALIFORNIANA, N. SP.
Plate 2, Figure 2

Shell large, elongate, subquadrate; compressed posteriorly; anterior dorsal margin short, curving regularly to meet the broad curve of the anterior end, base only slightly curved; posterior end irregularly rounded; dorsal margin nearly straight for a distance about two-thirds the total length of the shell. Posterior area not definitely limited by carinæ but showing an indistinct medial groove. Umbones inconspicuous, beaks small, nearly adjacent. Surface of shell ornamented by a very few irregular low elevations and by concentric lines of growth. Length of type, 111 mm.; height, 80 mm.; diameter, 35 mm.

Type number 6 Condon Museum, University of Oregon. Type from University of Oregon locality number 90, Ager, Siskiyou County, California.

An internal mold from Ager, Siskiyou County, California, apparently belongs to this species. The pallial line of this specimen nearly meets the conspicuous impression representing the anterior cardinal. The posterior extremity has two indistinct linear depressions extending from the margin to the pallial line. The posterior muscle impression is large, and slightly depressed.

Another specimen, apparently belonging to this species, from Sites, Colusa County, California, and loaned by the California Academy of Science (12784), shows a few very prominent rounded pustules arranged in oblique rows on the anterior end of the disk. These indicate that this species has much more prominent ribs than does the allied species *T. tryoniana,* from which it differs in its more elongate, and thus less quadrate outline and lack of the conspicuous radiating grooves described by Gabb and clearly shown on the type.

This species has been recognized from Ager, Siskiyou County, Sites, Colusa County, California, and questionably from the Horsetown beds of Shasta County, California.

Horizon: Chico, and possibly Horsetown Cretaceous.

TRIGONIA JACKSONENSIS, N. SP.

Plate 4, Figure 1

Shell elongate, very tumid medianly, compressed posteriorly; anterior dorsal margin and anterior end broadly rounded, base line nearly straight curving upwards to the elongate and probably truncate posterior extremity; dorsal margin concave just below the over-hanging umbones, thence sloping to the posterior end. Umbonal ridge conspicuous for about one-half the distance from the beak to the posterior basal margin; escutcheon imperfectly shown but probably ill-defined by a ridge. Umbones very tumid, beaks blunt and conspicuously opisthogyrate. Ornamentation on disk apparently restricted to about twenty low, closely spaced concentric costæ which are slightly nodose where they cross the heavier incremental lines of growth. Costæ extend from the anterior and dorsal margins to the middle of the disk, except on the umbone where they seem to extend to the umbonal ridge. Posterior and basal portions of the disk without ridges or pustules; sculpture of escutcheon imperfectly shown but apparently not developed. Interior unknown. Length of type, 76 mm.; height, 55 mm.; convexity, 31 mm.

Type number 5 Condon Museum, University of Oregon. Type from University of Oregon collecting locality number 89, Jacksonville, Jackson County, Oregon.

This representative of an essentially Jurassic group appears to belong to the excentrica subgroup since it is apparently allied to *T. laeviscula* Lycett, a European Jurassic species. Its peculiar sculpture readily distinguishes this from other described West Coast species.

As yet this species is known only from its type locality at Jacksonville, Jackson County, Oregon.

Horizon: Upper Cretaceous, Chico group.

TRIGONIA TRYONIANA GABB

Plate 4, Figure 4

Trigonia tryoniana Gabb, Pal. Cal. Vol. 1, p. 188, pl. 25, fig. 176, 1863. Whiteaves Mesozoic Fossils, Vol. 1, p. 161, pl. 18, fig. 7, 1876. Gabb originally described this species as follows:

> Shell elongate, subquadrate, narrowest behind; beaks anterior, not prominent, subterminal; hinge line straight, obliquely sloping; anterior end rounded, base convex in front, straight and sloping upwards behind, posterior end convexly subtruncated. Surface marked by two radiating grooves, one of which passes from the beaks to the posterior basal angle; the other is above it; between the first and the anterior ends are arranged oblique series of elongated tubercles. These are all crossed by numerous, fine, concentric lines of growth, and occasional irregular undulations.

Length of type, 75 mm.; height, 50 mm.

Type number 11955 Palæontology Department Collection, University of California, type from Tuscan Springs, Tehama County, California.

Gabb reported this species only from Tuscan Springs, Tehama County, California. Packard[8] reported it from the Turritella zone of the Chico of the Santa Anna Mountains, California. It was reported by Whiteaves from Northwest Bay, Vancouver Island, and questionably by Yehara[9] from Hokkaido, Japan.

This species differs from the other members of this group in its less attenuated posterior extremity and the presence of conspicuous rows of pustules on the anterior and basal portions of the shell and the two radiating grooves on its posterior dorsal area.

Horizon: Upper Cretaceous, Chico group.

GROUP: QUADRATÆ AGASSIZ

Example: *Trigonia daedalea* Parkinson

Plate 1, Figure 1

Shell quadrate; area flattened and indistinctly limited; escutcheon ornamented; tuberculated costæ, irregularly arranged on the side of the valve. Interior with divisional siphonal ridge.

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[8] Packard, E. L. Faunal Studies in the Cretaceous of the Santa Ana Mountains, Southern California, University of California, Publ. Bull. Dept. Geol., Vol. 9, p. 147, 1916.

[9] Yehara Shingo, *Op. cit.*, p. 43.

Geologic range: Cretaceous

This group is represented by *Trigonia leana* Gabb, *T. leana* var. *whiteavesi,* n. var., and *T. fitchi,* n. sp.

TRIGONIA FITCHI, N. SP.

Plate 6, Figure 3; Plate 7, Figure 2

Shell ovoid, compressed posteriorly; anterior dorsal margin sloping abruptly to the short and broadly rounded anterior extremity; base arcuate; posterior extremity apparently broadly rounded, dorsal margin imperfectly known but probably nearly straight for about one-half the distance from the beak to the posterior extremity. Posterior dorsal area broad and flattened posteriorly; no defined escutcheon. Umbones low. Median and anterior portion of shell ornamented by about fifteen conspicuous, concentric, costæ, curving anteriorly; ribs originate along an indistinct carina extending from the beak to the posterior basal margin and extend ventrally nearly to the base where they bend anteriorly, the curve being more abrupt near the extreme anterior margin of the disk; costæ separated by narrow interspaces; costæ consisting of irregularly shaped yet regularly disposed low pustules, which become larger and less numerous posteriorly; posterior extremity and dorsal area apparently devoid of sculpture except for the crude lines of growth. The internal mold of the right valve of the type specimen has an indistinct pallial line and a slight marginal depression which connects indistinctly with a groove just ventral to the inconspicuous posterior muscle scar. Hinge unknown. Length of type, 68 mm.; height, 55 mm.; diameter, about 25 mm. Named in honor of Mr. Chester Fitch, Medford, Oregon.

Type number 7, Condon Museum, University of Oregon. Type from University of Oregon locality number 93, Griffin Creek, Jackson County, Oregon. A specimen from locality 98, Ager, Siskiyou County, California, is thought to belong to this species. It possesses a larger number of slightly more regular pustules, otherwise it appears to be the same as the type.

This new species might be confused with *T. leana* from which it differs in having a larger number of ribs and more numerous pustules, as well as the abrupt manner with which the costæ bend anteriorly near the basal margin of the shell.

This species has been recognized only in the Chico of Griffin Creek, Bear Creek Valley area of Oregon, and at Ager, Siskiyou County, California.

Horizon: Upper Cretaceous, Chico group.

TRIGONIA LEANA GABB

Plate 5, Figures 1, 2, 3, 5, and 6; Plate 6, Figure 1; Plate 7, Figure 1

Trigonia leana Gabb. Acad. Nat. Sci. Proc. Philadelphia, 1876, p. 312.

Trigonia gibboniana Lea, Trans. Am. Phil. Soc. 1840, p. 255, pl. 9, fig. 7. Gabb, Pal. Cal. Vol. 1, p. 190, pl. 25, fig. 178, and pl. 31, fig. 262, 1863.

Gabb described this form as follows:

> Shell rounded, subquadrate, compressed; beaks anterior, subterminal; cardinal and basal margins nearly parallel, the former nearly straight, the latter broadly convex; anterior end broadly rounded, straight near the beaks; posterior end truncated obliquely above, vertically below.
>
> Surface in adult specimens marked by about thirteen nodose ribs, starting from a line drawn from the beaks to the posterior basal angle, and running obliquely downwards and forwards; those nearest the beaks becoming more oblique and somewhat curved; above are some smaller pustular ribs, or rows of small tubercles, running parallel with the corresponding posterior margin of the shell. In very young specimens all of the ribs are reduced to rows of distinct tubercles, and those on the cardinal border change their direction somewhat. Besides these, on two specimens from Martinez, is a single row of small, isolated tubercles, placed between the two rows of ribs.

The dimensions as obtained from Gabb's original figure are: Length, 72 mm.; height, 59 m. m.

Type specimen is possibly in the Philadelphia Academy of Sciences. Type from near Martinez, Contra Costa County, California.

Trigonia leana is abundant in the Chico Cretaceous of the Bear Creek Valley area of Oregon. It is there represented by specimens showing considerable form variation. Figure 4, plate 5, shows one extreme, being nearly circular in outline, while figure 7, is more elongated and more nearly typical. The costæ are low and ridge-like on most of the specimens from Southwestern Oregon, but are more nodose on a form from Eastern Oregon, California and the Queen Charlotte Islands.

This species possesses less conspicuous costæ than does the form *T. leana* var. *whiteavesi.* It differs from *T. fitchi* in the straighter character of the costæ and in the lesser number of pustules on the ribs.

Horizon: Upper Cretaceous, Chico group.

TRIGONIA LEANA, VAR. WHITEAVESI, N. VAR.

Plate 5, Figure 4; Plate 6, Figure 2

Trigonia, sp. indet., Whiteaves. Mesozoic Fossils, Vol. 1, p. 70, pl. 10, figs. 2, 2a, 1876.

Whiteaves described a nodose form from the Queen Charlotte Islands, which appears deserving of a varietal name. His description follows:

> Shell compressed, elongate, subtrapeziform, narrowest behind; anterior end very short, posterior produced; length much greater than the height. Beaks small, anterior, subterminal, slightly recurved, not much elevated above the superior border. Lunule none; posterior area flattened laterally, with a rounded margin, made up of two elongately subtriangular spaces, one on each side of the hinge line; ligament external, short, thick, prominent and transversely striated. Hinge line straight, sloping gently downwards; posterior end obliquely subtruncate. Anterior end almost straight, but curved a little outwards; antero-ventral margin broadly rounded; base line convex in the middle, straighter, and curving much more gradually upwards behind.

Out of nine specimens on which the test is partly preserved and a number of imperfect casts, none show the true characters of the whole of the surface ornamentation. The original of figure 2, on plate X (Whiteaves), gives the clearest idea of the normal shape of the shell, besides showing the sculpture of the beaks and posterior area. Figure 2a, on the same plate, is a representation of the most perfect of four distorted individuals which have been compressed laterally, and whose exterior is either worn, exfoliated, or partly covered by the tenacious matrix. The only information afforded as to the sculpture of the main body of the shell, is that supplied by the four last-mentioned examples. In these there appear to be about thirteen or fourteen obliquely transverse, concavely, curved rows of separate raised tubercles. The whole of the rows commence at the outer edge of the posterior area, and they all run obliquely downwards and forwards. Rather more than half terminate at the anterior margin, but just before reaching it they each turn abruptly upwards. The upward bend at the front margin consists only of a change of direction of the last tubercle, and there is a solitary intervening one. at this end, between each of the two rows. The rest of the rows curve obliquely from the posterior area to the ventral border. One specimen shows very coarse and concentric raised striæ of growth, with corresponding grooves; also, that the tubercles are longitudinally elongated. It is possible, indeed, that instead of rows of distinct and separate tubercles, the true sculpture may have consisted of oblique ribs which are interrupted and made tubercular by their being crossed by the concentric grooves just described.

The posterior area is transversely striated, and in one individual there is a faint longitudinal groove, bordered by an obtuse ridge, which runs the greater part of the length of its outer margin. Occasionally there are a few scattered tubercles in this region, but these are often absent, and when present are generally, though not always, most numerous near the beaks.

Length as measured on the original figure, 80 mm.; height, 66 mm.

Whiteaves does not give the exact locality on Queen Charlotte Islands where the figured specimen was obtained. It is probable that it came from the north side of Maude Island, for at that locality, similar forms make up shell beds frequently two feet in thickness. However, good material was not obtained due to the fragmental character of the shells and the hardness of the matrix.

This form also seems to be represented in California and possibly Oregon. An excellent specimen from Pigeon Point, San Mateo County, California, now in the collections of the California Academy of Sciences, agrees with the northern form in the general character of the costæ, the transverse ridges of the escutcheon, and general outline. It differs, however, in its more regularly arranged costæ, composed of evenly spaced and well-rounded tubercles, especially on the umbonal and anterior regions. Posteriorly the tubercles are slightly more irregular in shape and distribution.

Such a condition suggests that that specimen has passed through a phylogenetic stage in which the entire disk was covered by ridge-like costæ having small tubercles, later these ridges must have broken up, forming definite rows of pustules. A later stage perhaps represented by *T. leana whiteavesi* would be attained by a widening of the inter-costal spaces and the development of the broader type of pustules. A still later stage in such a series would probably be the reduction of the number of costæ, which might at the same time become low, broad pustules producing low, indistinct ridges. Such a form might be like the specimen figured on plate 5, figure 4.

Trigonia leana whiteavesi differs from the typical form in having more conspicuous pustules and in having the dorsal area ornamented, at least near the umbones by transverse ridges. It differs from *T. fitchi* in having the ornamented escutcheon.

Horizon: Upper Cretaceous, Haida formation and possibly the Chico group.

GROUP: SCABRÆ AGASSIZ

Type species: *Trigonia scabra* Lamarck

Shell crescentic; posterior extremity produced; umbones high, beaks conspicuously incurved; posterior area wide, excavated, and ornamented by transverse costellæ; costæ ridge-like, imperfectly tuberculated; divisional siphonal ridge conspicuous; hinge supplemented by a series of transverse denticulations on a narrow, flattened plate bordering the hinge plate.

Geologic range: Jurassic and Cretaceous

This group has been divided into three subgroups named after the species *T. aliformis* Parkinson (plate 1, figure 4), *T. pennata* Sowerby (plate 1, figure 6), and *T. spinosa* Parkinson ,(plate 1, figure 7). The first is characterized by having an attenuated posterior extremity; the second by having a depressed space below the umbonal ridge, which is devoid of costæ or has an ill-defined series of perpendicular ridges; the third is characterized by having a more rounded shape, and having costellæ and costæ that diverge from the angles of the valves.

This group is represented by the following West Coast species:

Jurassic
    Trigonia plumasensis Hyatt
Cretaceous
    Trigonia æquicostata Gabb
    Trigonia columbiana, n. sp.
    Trigonia deschutesensis, n. sp.
    Trigonia evansana Meek
    Trigonia evansana, var. oregana, n. var.
    Trigonia flexicostata Burwash
    Trigonia inezana. n. sp.
    Trigonia maudensis Whiteaves
    Trigonia newcombei, n. sp.

SUBGROUP: ALIFORMIS

TRIGONIA COLUMBIANA, N. SP.

Plate 11, Figures 1 and 3

Shell large, tumid, nearly as high as long; anterior dorsal margin curving abruptly to the rounded anterior end; basal margin sloping upwards anteriorly and posteriorly from a point somewhat posterior to the vertical from the beak; posterior end attenuated and probably bluntly pointed; posterior dorsal margin concave upwards. Umbones and anterior portion of the shell gibbose, but becoming less so posteriorly where the end is distinctly flattened. Posterior dorsal area ovate, excavated, and limited by a conspicuous umbonal ridge or carina. Disk ornamented by about ten oblique, nearly straight costæ, which are broad, heavy, rounded ridges apparently lacking any tendency to become tubercular. The three or four posterior costæ are less conspicuous, especially near the umbonal ridge. Those on the anterior end tend to become obsolete near the ventral margin. Posterior end and dorsal area devoid of sculpture, other than irregular growth lines. Length, 73 mm.; height, 65 mm.; diameter, 53 mm.

Type number 11, Condon Museum, University of Oregon. Type from University of Oregon locality 104, east of Queen Charlotte City, Queen Charlotte Islands, B. C.

This peculiarly shaped and uniquely ornamented species apparently belongs to the aliformis subgroup of the Scabræ. The several specimens belonging to this species show considerable form variation, certain of them being much more elongate than the type. The outline of the cotype is more complete than that of the type and has been reconstructed and figured. This species is very distinctive and would not likely be confused with any other known species from the same region.

Horizon: Upper Cretaceous, Haida formation

TRIGONIA DESCHUTESENSIS, N, SP.

Plate 10, Figure 3

Shell small, triangular, the basal and anterior margins nearly forming a right angle; the dorsal posterior margin sloping in a nearly straight line to the narrow and elongate posterior extremity; posterior dorsal area limited by a conspicuous umbonal ridge which was apparently bipartite. Sculpture unknown, the type being an internal mold, which shows at least fourteen ridges separated by broad interspaces; muscle scars conspicuous. Length of type, 45 mm.; height, 45 mm.; diameter, 32 mm.

Type number 9, Condon Museum, University of Oregon. Type from Crooked River, Eastern Oregon, kindly presented by Mr. Stanley Myers, of Portland, Oregon.

This species evidently is most closely related to *T. inezana* and distantly related to *T. evansana* and certainly belongs to the same subgroup. Its unique shape readily separates it from either of these species and possibly justifies the description of a mold. It resembles the Japanese species *T. longiloba* Jumbo, from which it differs in having a less curved base and a less produced posterior extremity.

This species is represented by another specimen in the Condon Museum, the locality of which has been lost. It was thought to represent a distorted specimen of *T. evansana,* but the discovery of a second specimen nearly identical in outline proves such a conclusion improbable.

Horizon: Upper Cretaceous, Chico group.

TRIGONIA EVANSANA MEEK

Plate 9, Figures 5 and 6

Trigonia evansana Meek, Trans. Albany Inst. Vol. 4, p. 42. Gabb, Pal. Cal. Vol. 2, p. 247; 1869. Whiteaves, Mesozoic Fossils, Vol. 1, p. 161; 1876.

Trigonia evansi Meek, Bull. U. S. Geol. and Geog. Surv. Terr. Vol. 2, p. 359, pl. 2, figs. 7, 72, and 7b. 1876. Gabb, Pal. Cal. Vol. 1, p. 189, pl. 25, fig. 177; 1863.

Meek originally described this species as follows:

> Shell arcuate-subtrigonal, gibbous anteriorly, contracted, cuneate, and slightly gaping behind; ventral margin deeply rounded in outline in the middle; anterior side very short, rounding up nearly vertically to the beaks; posterior extremity quite narrowly rounded, or subtruncated; dorsal margin very concave in outline, and sharply carinate or erect along its whole length; escutcheon lanceoval, being widest anteriorly, where it is distinctly concave on each side of the carina formed by the erect dorsal margins of the valves, bordered along each side by a low ridge commencing very narrow at the beaks and widening gradually posteriorly, with a well-defined narrow mesial sulcus along the entire length of these ridges; concave space within these ridges ornamented by small, nearly smooth, transverse costæ, extending up to the dorsal margin; beaks nearly terminal, rather narrow, erect, and strongly incurved at nearly right angles to the longitudinal axis of the valves. Surface ornamented by from eighteen to about twenty-two angular transverse costæ that terminate abruptly above, along the low ridge bounding the escutcheon; costæ sometimes slightly crenated, particularly those on the more gibbous anterior region; lines of growth moderately distinct. Internal cast showing only obscure traces of the costæ; posterior muscular impression deep; pallial line moderately distinct.

Length of type 67.3 mm.; height, 47.2 mm.; convexity, 36.1 mm.

The type came from Nanaimo, Vancouver Island. The holotype is number 12452, and the cotypes 7529 and 12452, U. S. National Museum.

This species has been generally confused with a common Californian species, *T. inezana.* This confusion may be traced to the description and figures of *T. evansana* given by Gabb, in which a specimen lacking the characteristic, broad bipartite area was incorrectly referred to Meek's form. This typical species might also be confused with the variety *T. evansana oregana* from which it differs in being less produced posteriorly and having a relatively wider ornamented area. It differs from the allied form *T. deschutesensis* in the more rounded character of the anterior end and the broader posterior extremity.

A specimen from Henley, Siskiyou County, California, shows the broad bipartate area of the typical species but has a less elongate outline and a sharper ridge-like, tuberculated costæ. A similar specimen in the Condon Museum strengthens the belief that ultimately good material will be found and that these two specimens will prove to have at least subspecific value.

The specimen figured by Yehara[10] as *T. hokkaidoana* is very nearly identical in outline and sculpture to the Nanaimo species, the only observable differences being the narrower dorsal smooth area.

This species has been reported from numerous Chico localities from Southern California northward to the type locality, but in some instances it is known to have been confused with other members of the aliformis subgroup so its geologic range is still imperfectly known.

Horizon: Upper Cretaceous, Chico group and possibly uppermost Horsetown.

TRIGONIA EVANSANA VAR. OREGANA, N. VAR.

Plate 9, Figure 7

Shell crescentic, elongate; anterior dorsal margin converging regularly to meet the even curve of the base; posterior dorsal margin concave, meeting the truncated attenuated posterior end; posterior area strongly differentiated from the median area of the shell by an ornamented dorsal area, which is narrow at the beaks but becomes wider and flatter toward the posterior extremity, and is further characterized by a median groove which is more conspicuous near the posterior end; escutcheon distinct, extending nearly to the posterior extremity, being depressed along the outer margin but raised at the inner margin of the valve; umbones rather conspicuous; beaks sharply pointed and strongly incurved. Median and anterior portions of disk ornamented by about twenty strong, narrow concentrically curved ribs, the anterior nine of which bear small, low, evenly spaced nodes, the remaining being even-crested and being about one-fourth as wide as the flat interspaces; escutcheon ornamented by ribs corresponding in number, position, and direction with the ribs below the unornamented dorsal area. Dentition and interior unknown, the type specimen being an exterior mold of the left valve. Length of type, 70 mm.; height, 50 mm.; convexity, about 18 mm.

Type number 4 Condon Museum, University of Oregon. Type from University of Oregon locality number 88. Crooked River, Eastern Oregon.

This new variety is allied to several other members of the Scabræ group that occur within the Indio-Pacific province. The broad bipartite dorsal area and relatively long posterior extremity distinguishes it from *T. evansana* with which it has been confused. It differs from *T. datemasamunei* Yehara in having a wider interrib space and from *T. kotoi* Yehara in its less conspicuously tuberculated ribs. The sculpture of the escutcheon separates it from *T. longiloba* Jumbo while the less attenuated posterior extremity serves to distinguish it from *T. yokoyamai* Yehara.

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[10] Yehara, Shingo. *Op. cit.*, pl. 1, figs. 1-8.

This variety has been recognized from the Chico group of the Crooked River area, Wheeler County, and questionably from Jacksonville, Jackson County, Oregon.

Horizon: Upper Cretaceous, Chico group.

TRIGONIA INEZANA, N. SP.

Plate 8, Figures 1a, and 1b; Plate 9, Figure 1, and Plate 10, Figure 1

Shell large, trigonal, anterior dorsal margin very short, curving sharply to the angulated basal margin; ventral margin broadly curved; posterior dorsal margin strongly concave curving upwards and meeting the basal margin in a bluntly-pointed end; umbones prominent, beaks strongly incurved, widely separated; posterior dorsal area bordered by a rounded double rib which widens slightly posteriorly; between this ridge and the strongly raised inner margins of the shell, the corselet is depressed, being ornamented by thirteen to fifteen prominent, broad, transverse costellæ. Disk ornamented by numerous broad ridge-like costæ which extend nearly to the basal margin, where they bend slightly forwards, this condition being more conspicuous on the wide anterior end; interspaces between the ribs regularly concave and crossed by heavy lines of growth which give an imbricated appearance to the costæ. Hinge unknown. Posterior extremity with conspicuous divisional siphonal ridge. Pedal scars deeply impressed. Length of type, 82 mm.; height, 72 mm.; diameter, 57 mm.

Type in the University of California Collection. Type from the Santa Ynez Mountains, California.

This species is probably identical with the California species referred by Gabb to *T. evansana*. It differs from Meek's species in having a narrow bipartite area, besides being less rounded anteriorly. This Californian species has a more rounding basal margin than does *T. deschutesensis* to which it is closely allied.

Another specimen from Chico Creek, Butte County, California, presumed to belong to this species shows sharper costæ than does the type.

T. inezana occurs abundantly in the Californian Upper Cretaceous, where it has been confused with *T. evansana*.

Horizon: Upper Cretaceous, Chico group.

SUBGROUP: PENNATÆ

TRIGONIA ÆQUICOSTATA GABB

Plate 9, Figure 3

Trigonia aequicostata Gabb, Pal. Cal. Vol. 2, p. 196; ibid. Vol. 1, pl. 26, fig. 198. Gabb described this form as follows:

> Shell small, trigonal, elongate; beaks prominent, anterior; cardinal margin sloping posteriorly; straight to slightly convex or concave; anterior end regularly rounded; base broadly rounded, most prominent in the middle; posterior

end narrowly truncated. Surface marked by regular, square, concentric ribs, with equal, flat, interspaces; these ribs end abruptly in advance, and are continued by fine lines starting with an angle somewhat less than a right angle; posteriorly there is an angular ridge running from the beak to the posterior basal angle, and on crossing this the ribs curve upwards towards the margin. Internally, the surface is marked by four or five radiating ribs under the beak; this character is not always present; the hinge teeth are unusually large, are coarsely ribbed, the anterior tooth being supported longitudinally by a vertical plate, starting from the upper edge of the muscular scar.

Length of type, 40 mm.; height, 28 mm.

The type came from Orestimba Canyon, Contra Costa County, California. This species has also been reported from near Mount Diablo, at Martinez and at Cottonwood Creek, Tehama County, California, and also at Jacksonville, and Riddle, Oregon. Two of these localities are thought to represent Horsetown horizons, but two of the others are undoubtedly Chico. Such an age is also probable in the case of two specimens in the Condon Museum which are labeled ''Siskiyou Mountains,'' a region in which the Horsetown has not yet been definitely recognized.

This species was based upon imperfectly preserved material and has never been adequately figured. Unfortunately none of the specimens known are much better than those described by Gabb so that little can be added to the published information regarding this species. The possibility that this form is identical with *T. maudensis* or *T. newcombei* is slight for neither of those species possesses the sculpture of the dorsal area which was described by Gabb as extending horizontally to the umbonal ridge which they cross before curving upwards to the margin. This characteristic would serve to distinguish this species from other known members of the same group.

Horizon: Upper Cretaceous, Horsetown and Chico.

TRIGONIA CONDONI, N. SP.

Plate 8, Figure 2

Shell small, about two-thirds as high as long; anterior dorsal margin slightly convex, curving regularly to the broadly produced anterior extremity; base rounded; posterior extremity long but abruptly and obliquely truncated; posterior dorsal margin somewhat concave; posterior area limited by a conspicuous umbonal ridge, which flattens and becomes nearly obsolete at the posterior extremity. Escutcheon ill-defined, being represented by an indistinct depression lying dorsal to the umbonal ridge, and extending about one-third the distance to the beak. Umbones slightly anterior, beaks sharply pointed. Median and anterior portions of the disk ornamented by about fifteen costæ occasionally bearing inconspicuous nodes, becoming more nodose anteriorly; the seven posterior costæ extend from the area in slightly oblique lines to the base; the anterior series consists of about eight ribs paralleling the posterior ones only for a short distance where they turn abruptly along a line passing from the beak to the median part of the base; the most anterior rib of the posterior series forks where it crosses that line; anterior series of costæ, broad, somewhat irregular, but lacking well-defined nodes; escutcheon apparently without sculpture other than conspicuous growth lines; the broad area which includes the posterior of the shell also devoid of definite sculpture or carinæ. Dentition and interior unknown, the type being an external mold of the right valve. Length of type, 56 mm.; height, 38 mm.; convexity, about 10 mm.

Type number 3, Condon Museum, University of Oregon. Type from University of Oregon locality number 85. Bed of one of the creeks emptying into Rogue River near Grants Pass. Condon collection.

Named in honor of Dr. Thomas Condon, Oregon's pioneer geologist and founder of the Condon Museum.

This species apparently belongs to this section since it meets the requirements except for the escutcheon which is imperfectly shown. It is much larger and has more irregular anterior costæ than *T. newcombei,* which it superficially resembles. It is somewhat like *T. flexicostata* in general outline, but lacks the wavy character of the anterior costæ of that species.

Horizon: Upper Cretaceous, Chico group.

TRIGONIA FLEXICOSTATA BURWASH

Plate 7, Figure 3

Trigonia flexicostata Burwash, Trans. Royal Soc. Canada, Third Sec., Vol. 7, p. 82, plate 3, fig. 3, 1913.

The type now in the Department of Geology, University of Chicago, was obtained from Maude Island, Skidegate Inlet, Queen Charlotte Island, B. C. This species is based upon two internal molds showing the interior of the left valves. The specimens, however, show faint impressions of costation, giving an imperfect idea of the probable character of the specimen and indicating that it probably belongs to the pennate subgroup. Two imperfect specimens in the Newcombe collection are questionably referred to this species.

Horizon: Upper Cretaceous, Haida formation.

TRIGONIA MAUDENSIS WHITEAVES

Plate 9, Figure 2

Trigonia maudensis Whiteaves, Canada Geol. Surv. Mesozoic Fossils, Vol. 1, p. 230, pl. 31, fig. 2, 1876-1903.

Whiteaves originally described this species as follows:

> Shell moderately convex, longer than high, very inequilateral; anterior end short and rounded; posterior end produced into a rather long and pointed beak, which narrows gradually both above and below, and whose lower margin is

somewhat convex and upper margin shallowly concave. Umbones narrow but very prominent, placed about half way between the center and the farthest extremity of the anterior end; beaks, small, curved inwards and downwards; posterior area well defined and bounded by a rather prominent carina, which is acutely angular near the beaks and obtusely angular behind the middle of the valves.

The front and central portions of the sides of the valves are marked by simple concentric ribs, but at the pointed extremity of the posterior third of the sides these concentric ribs are crossed by a few radiating costæ, which commence at or a short distance below the outer boundary of the posterior area and extend to the ventral region. In the most perfect specimen, which was collected at Maud Island, there are five radiating ribs in the posterior extremity, two of which, the ones nearest to the anterior end, are comparatively broad, while the three behind them are very narrow and inconspicuous. In two moulds of the exterior of a small *Trigonia* from Cumshewa Inlet, however, which probably belongs to this species, there are indications of four or five very coarse radiating ribs on the posterior extremity of the sides, all of which are of equal breadth. Posterior area marked by very oblique raised striæ.

Length, 34 mm.; height, 24 mm.

Type from the Haida Cretaceous of the north side of Maude Island, Skidegate Inlet, Queen Charlotte Islands, B. C. A photograph of the type, kindly furnished by Mr. F. H. McLearn, of the Geological Survey of Canada, is herein reproduced.

A single specimen obtained at University of Oregon locality 104 shows an imperfect external mold of a small *Trigonia.* This has very conspicuous oblique ribs on the dorsal area and concentric ridges on the umbone, similar to those of *T. maudensis.* This form differs materially from any other known West Coast species.

This representative of the pennatæ subgroup, quite closely resembles *T. newcombei* from the same general region. Whiteaves' species has a distinctive type of ornamentation on the posterior end which is not even suggested by the ribbing of a number of specimens of the herein described species. The Japanese form *T. subovalis* Jimbo has the same general outline but lacks the angulated ribbing and has a differently sculptured escutcheon.

This species has been reported by Whiteaves from Maude and South (Sandilands) Islands, and from the north shore of Cumshewa Inlet, Queen Charlotte Islands.

Horizon: Upper Cretaceous, Haida formation.

TRIGONIA NEWCOMBEI, N. SP.

Plate 9, Figure 4; Plate 10, Figures 2, 4 and 6; Plate 11, Figure 2

Shell small, more than two-thirds as high as long; anterior dorsal margin nearly straight or slightly concave upwards; posterior extremity produced, obliquely truncated above; base broadly rounded from a slightly indented region at the posterior basal margin, to the evenly rounded anterior end; posterior dorsal margin forming a continuation of the curve of the anterior end. Posterior dorsal area broadly ovate, lanceolate; limited by a conspicuous umbonal ridge which flattens posteriorly. Umbones situated anteriorly, high, beaks pointed and incurved. Disk ornamented by two series of costæ; anterior series consists of twenty or more, broadly rounded or slightly nodose costæ, which are nearly horizontal except near the anterior margin where they trend upwards as indistinct ridges; umbonal costæ, closely spaced, evenly rounded, extending to the carina or umbonal ridge; costæ nearer the base, less regularly spaced, broader, slightly nodose, and terminating in or at the upward bending costæ which form the posterior vertical type of ornamentation. Posterior series consists of about seven radiating or nearly vertical costæ, being somewhat broader toward the base; about half of these reach to the base, the anterior one being continuous with alternate costæ of the horizontal series. Escutcheon ornamented by very fine, rounded, ridge-like costellæ, which under the beaks are slightly oblique to the margin, thence bending abruptly and terminating at the indistinct marginal carinæ or the umbonal ridge; the heavy growth lines obscure this sculpture at some distance from the beaks; area broad, extending as an unornamented region well below the umbonal ridge near the posterior end.

Hinge and interior of type unknown. Length of type, 47 mm.; height, 30 mm.; convexity, 16 mm.

Type number 10, Condon Museum, University of Oregon. Type from University of Oregon locality number 108. About one mile east of Queen Charlotte City, Skidegate Inlet, Queen Charlotte Islands, B. C.

Named in honor of Dr. C. F. Newcombe, who kindly placed his entire valuable Trigonia collection at the disposal of the author.

This species is abundantly represented in the Newcombe collection and by a number of specimens recently collected from the Haida Cretaceous of the Queen Charlotte Islands. The species shows considerable form variation, as well as marked variation in costation. In one case the growth lines almost obscure the costæ on the anterior portion of the disk. Another specimen shows very conspicuous anterior costæ and broad, slightly nodose posterior costæ. Still another type shows distinct nodes in place of the vertical costæ and has a series of undulating ventral anterior costæ. This latter specimen unlike the others is not clearly connected by gradational types of the typical form and may perhaps deserve varietal recognition. The hinge of this specimen has massive teeth. The internal molds indicate a strong depressed muscle scar and a divisional siphonal ridge.

This *Trigonia* known only from the Queen Charlotte Islands, might be confused with *T. condoni* from which it differs in the character of the ribbing. It also superficially resembles *T. diversicostata* described from the same region. The new species lacks the conspicuous costation of the dorsal area which Whiteaves referred to as being "boldly and longitudinally" ribbed. It also possesses a much larger number of anterior costæ. The lack of ornamentation on the posterior extremity readily distinguishes it from another Queen Charlotte species, *T. maudensis*. It resembles more closely *T. subo-*

valis Jimbo from which it differs in a lesser number of vertical costæ.
Horizon: Upper Cretaceous, Haida formation.

TRIGONIA PLUMASENSIS HYATT

Plate 10, Figure 5

Trigonia plumasensis Hyatt. Bull. Geol. Soc. Am. Vol. 3, p. 407, 1892,

Only a preliminary description of this species was published by Hyatt. The following description is based upon a cast, from the typical molds kindly loaned by Dr. Stanton of the United States Geological Survey.

Shell large, trigonal, compressed; anterior dorsal margin extending as a straight line for a short distance, thence curving downwards, forming an even rounded anterior end; posterior basal margin nearly straight to the sharply pointed posterior end; basal margin obscured, apparently nearly straight; posterior area limited by a conspicuous umbonal ridge which serves to define the slightly depressed and apparently unornamented escutcheon; umbones low, adjacent, sharply pointed. Sculpture confined to the disk, consisting of three types; posterior region just below and anterior to umbonal ridge, ornamented by about twenty-two low, broadly rounded, nearly vertically arranged ridges, each terminating in an inconspicuous pustule, forming the posterior end of irregular rows of large rounded pustules covering a triangular area, having an apex near the beak; on the umbones the vertical series of costæ are seen to abruptly change into nodose, wavy, horizontal costæ, but in the middle region the pustules are less regularly arranged; the anterior costæ are concentric, ridge-like, the crests of which are nodose; these ribs extend from the triangular area to the anterior margin. Interior unknown, the lectotype being an external mold of a portion of both valves. Length of type, 67 mm.; height, about 44 mm.; convexity, about 10 mm.

Lectotype number 32480 U. S. National Museum. Type material from the Bicknell sandstone, Mount Jura, Taylorsville, Shasta County, California.

This highly ornamented species has the typical sculpture of the pennatæ subgroup of the Scabræ, upon the disk, but it seems to lack the sculpture upon the escutcheon, though the specimen is perhaps too poorly preserved to justify a very positive statement. It might thus possibly prove to be related to the Scaphoideæ.

A second specimen, (Number 32481, U. S. National Museum), from the type material has been referred by Hyatt to this species, but although it is too poor for description, it is possibly separable from the typical *T. plumasensis* on the basis of the very faint rows of posteriorly, instead of vertically or slightly anteriorly, directed minute pustules. These are widely separated and very inconspicuous compared to the large irregularly spaced pustules which occupy the remaining portion of the disk, even reaching the anterior margin of the shell without becoming ridge-like.

The characteristic sculpture readily distinguished this from other known West Coast species.

Horizon: Middle Jurassic, Bicknell sandstone.

Group: Costatae Agassiz

Type species: *Trigonia costata* Lamarck
Plate 1, Figure 3

Shell inequivalve, each valve having a distinct type of ornamentation. Area bounded by carinæ, bipartite, the upper portion being more depressed than the lower.

Geologic range: Essentially Jurassic

The following Jurassic species belong to this group:

Trigonia aff. costata Hyatt.
Trigonia aff. hemispherica Hyatt.

TRIGONIA AFF. COSTATA SOWERBY

Trigonia, n. sp. Hyatt, Bull. Geol. Soc. Am., Vol. 3, p. 402, 1892.

This species was listed by Hyatt from the Hardgrave sandstone of Taylorsville, California as *Trigonia,* n. sp. and was compared to the European species *T. costata.* The poorly preserved specimens have not been restudied.

Horizon: Lower Jurassic, Hardgrave sandstone.

TRIGONIA AFF. HEMISPHERICA LYCETT

Trigonia, n. sp. Hyatt, Bull. Geol. Soc. Am. Vol. 3, p. 305; 1892.

This species was likewise listed by Hyatt from Taylorsville, California with the statement that it is allied to the European species, *T hemispherica.* It therefore belongs to the Costatæ and resembles the preceding species, but probably possesses a larger number of ribs.

Horizon: Middle Jurassic, Mormon standstone.

Indeterminate Forms

Specific names have been given to several imperfectly preserved specimens. The following forms, lacking diagnostic specific characters, are considered as *nomina nuda,* excepting possibly that of the first named.

Trigonia consobrina Eichwald
Trigonia nana Eichwald
Trigonia paucicostata Burwash
Trigonia recticostata Burwash
Trigonia reniforme Burwash

TRIGONIA CONSOBRINA EICHWALD

Trigonia consobrina Eichwald, Bemerkungen über die Halbinsel Mangischlak und die Aleutischen Inseln. St. Petersburg, 1871, p. 182, pl. 14, fig. 7.

This species was based on a specimen from the "schwarzen Neocomkalksteine von Alaska." Without comparative material it is unwise to attempt even to assign this form to a section. If Eichwald's comparison to *T. crenulata* Lamarck is correct, the species belongs to the Scaphoideæ.

Horizon: Cretaceous.

TRIGONIA NANA EICHWALD

Trigonia nana Eichwald. Bermerkungen über die Halbinsel Mangischlak und die Aleutischen Inseln. St. Petersburg, 1871, p. 180, pl. 14, fig. 8.

The small specimen obtained from ("im schwarzen Neocomkalksteine der Bucht Tukusitnu,") Kenai, Alaska, represents an imperfect mold and although it was compared to *T. aequicostata* Gabb, there appears little hope of recognizing the species.

TRIGONIA PAUCICOSTATA BURWASH

Trigonia paucicostata Burwash, Trans. Royal Soc. Canada, Third Ser., Vol. 7, p. 85, pl. 3, fig. 5, 1913.

This species was based upon two internal molds of left valves obtained from Maude Island, Skidegate Inlet, Queen Charlotte Islands, B. C. The specimens might easily represent any one of several species. There seems, therefore, no justification in retaining the name based upon such inadequate material.

TRIGONIA RECTICOSTATA BURWASH

Trigonia recticostata Burwash, Trans. Royal Soc. Canada, Third Ser., Vol. 7, p. 83, pl. 3, fig. 4, 1913.

This species was based upon an internal mold of a left valve obtained from Maude Island, Skidegate Inlet, Queen Charlotte

Island, B. C. This specimen does not even show the general outline of the shell and therefore cannot be considered as a legitimate species.

TRIGONIA RENIFORME BURWASH

Trigonia reniforme Burwash, Trans. Royal Soc. Canada, Third Ser., Vol. 7, p. 84, pl. 2, figs. 1a, b, 1913.

This species was based upon three internal molds obtained from Maude Island, Skidegate Inlet, Queen Charlotte, B. C. The specimen figured does not even show the umbone. It might easily have belonged to any of several species and therefore cannot be considered as deserving a specific name.

Transmitted February 24, 1921. Issued May 13, 1921.

EXPLANATION OF PLATES

PLATE 1

All figures slightly reduced
(Reproduced from British Fossil Trigoniæ by Lycett.)

Figure 1.—*Trigonia daedalea* Parkinson. A typical European representative of the Quadratæ group.

Figure 2.—*Trigonia clavellata* Sowerby. A typical European representative of the Clavellatæ group.

Figure 3.—*Trigonia costata* Sowerby. The type species of the Costatæ group.

Figure 4.—*Trigonia aliformis* Parkinson. The type species of the aliformis subgroup of the Scabræ.

Figure 5.—*Trigonia litterata* Young and Bird. The type species of the Undulatæ group.

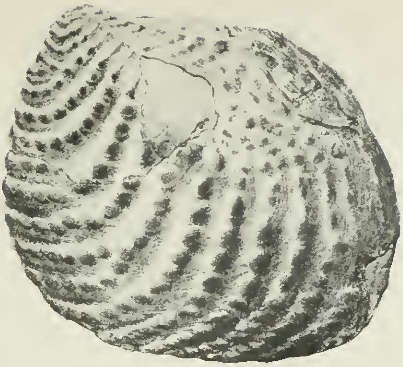
Figure 6.—*Trigonia pennata* Sowerby. The type species of the pennatæ subgroup of the Scabræ.

Figure 7.—*Trigonia spinosa* Parkinson. The type species of the spinosa subgroup of the Scabræ.

Figure 8.—*Trigonia excentrica* Parkinson. The type species of the excentrica subgroup of the Glabræ.

Figure 9.—*Trigonia navis* Lamarck. The type species of the Scaphoideæ group.

Plate 1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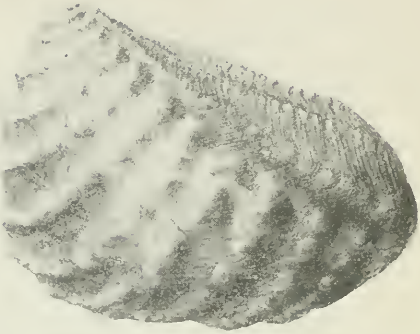
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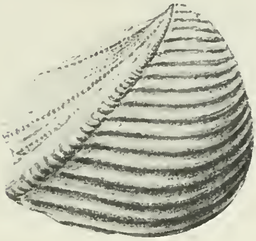
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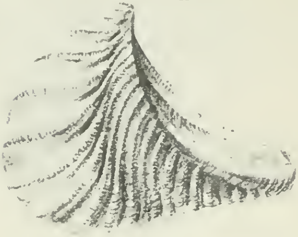
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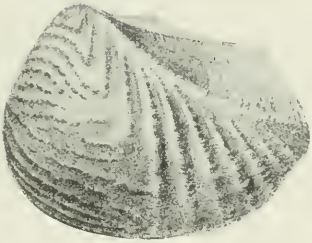
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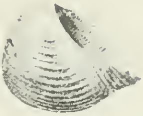
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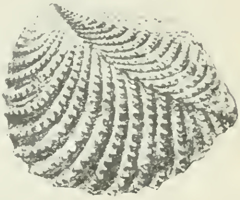
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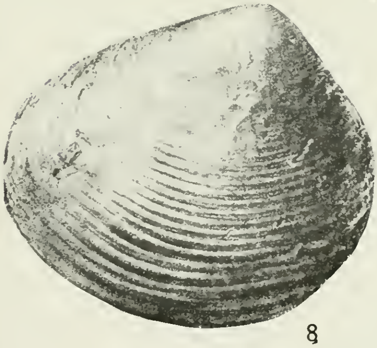
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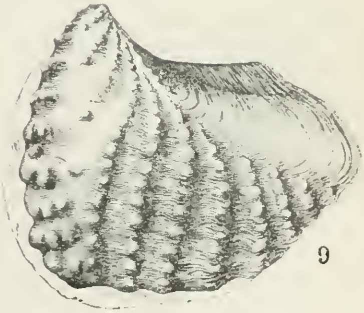
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Plate 2

All figures approximately natural size

Figure 1.—*Trigonia naviformis* Hyatt. Lectotype number 32478 U. S. National Museum. Middle Jurassic, Bicknell sandstone, Taylorsville, Cal.

Figure 2.—*Trigonia californiana*, n. sp. Type number 6, Condon Museum, from Upper Cretaceous, Chico group of Ager, Siskiyou County California.

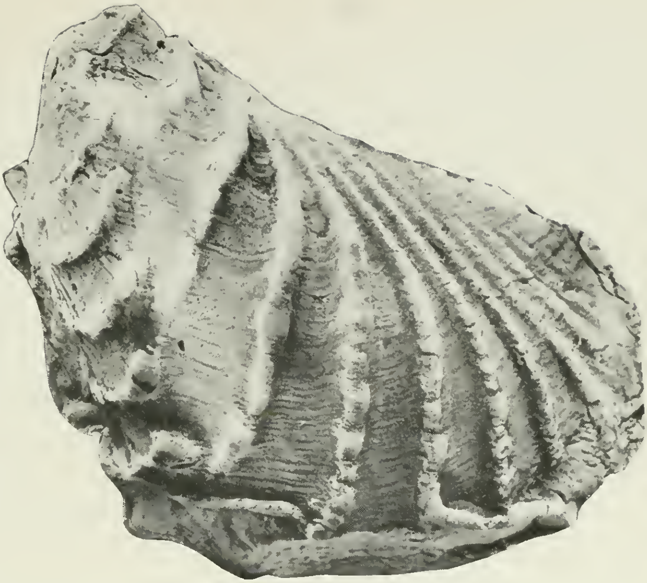

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PLATE 3

All figures approximately natural size

Figure 1.—*Trigonia charlottensis*, n. sp. Type specimen belonging to Dr. C. F. Newcombe, Victoria, B. C. Upper Cretaceous, Haida formation of Maude Island, Queen Charlotte Islands, B. C.

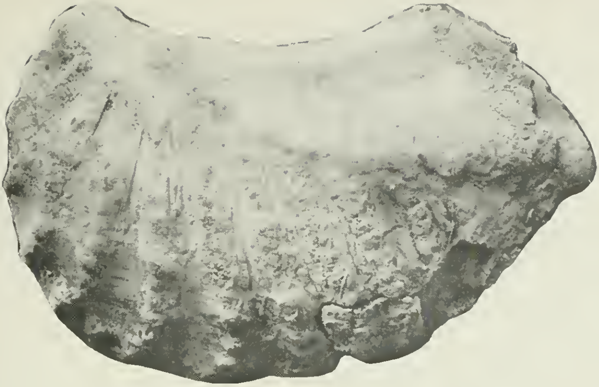
Figure 2.—*Trigonia doroschini* Eichwald. Reproduction of the original figure of the type presumably from the Middle Jurassic of Iniskin Bay, Cook Inlet, Alaska.

Figure 3.—*Trigonia doroschini* Eichwald. Reproduction of the original figure of the type.

Figure 4.—*Trigonia diversicostata* Whiteaves. Reproduction of the type specimen. Upper Cretaceous.

Figure 5.—*Trigonia obliqua* Hyatt. Lectotype number 32479 U. S. National Museum. Middle Jurassic, Bicknell sandstone, Taylorsville, California.

Figure 6.—*Trigonia obliqua* Hyatt. Mold of type material.



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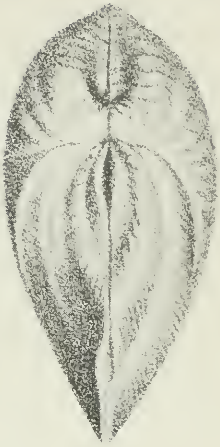

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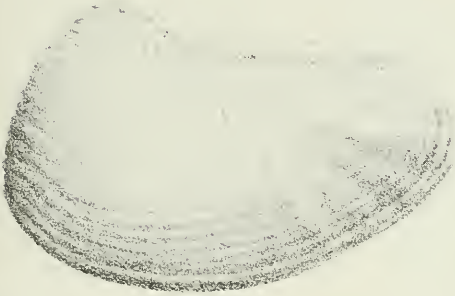

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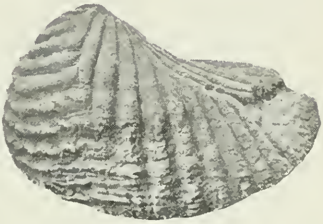

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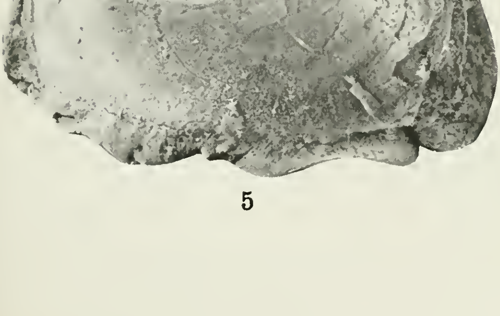

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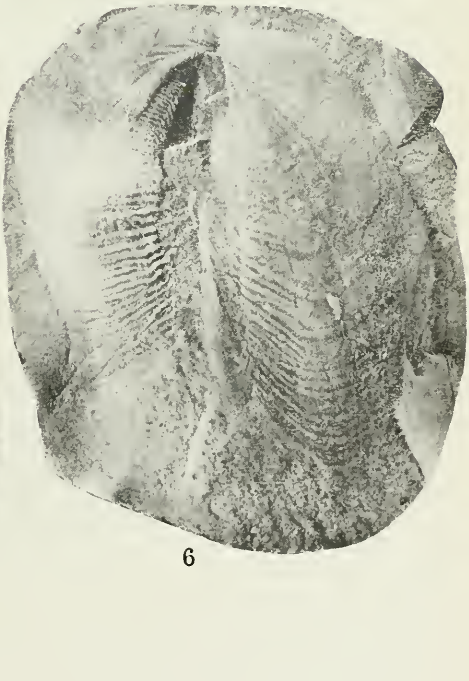

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PLATE 4

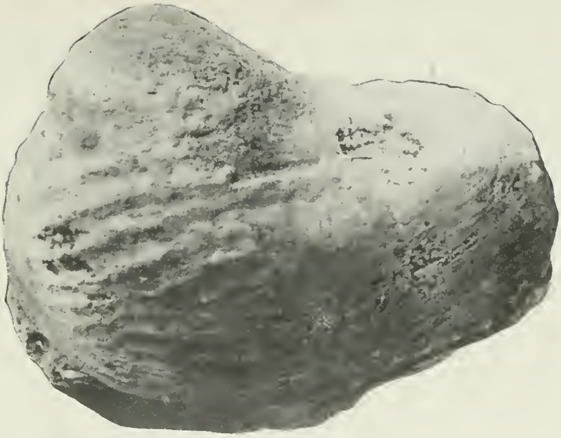
All figures approximately natural size

Figure 1.—*Trigonia jacksonensis*, n. sp. Type specimen. Upper Cretaceous, Chico group from Jacksonville, Oregon.

Figure 2.—*Trigonia dawsoni* Whiteaves. Reproduction of the original figure of the type. Middle Jurassic, Yakoun formation of Alliford Bay, Queen Charlotte Islands, B. C.

Figure 3.—*Trigonia pandicosta* Meek. Reproduction of the original figure of the type. Jurassic, Genesse Valley, Plumas County, California.

Figure 4.—*Trigonia tryoniana* Gabb. Reproduction of the type specimen. Upper Cretaceous, Chico group of Tuscan Springs, Tehama County, California.



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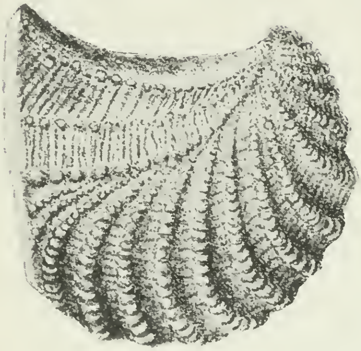

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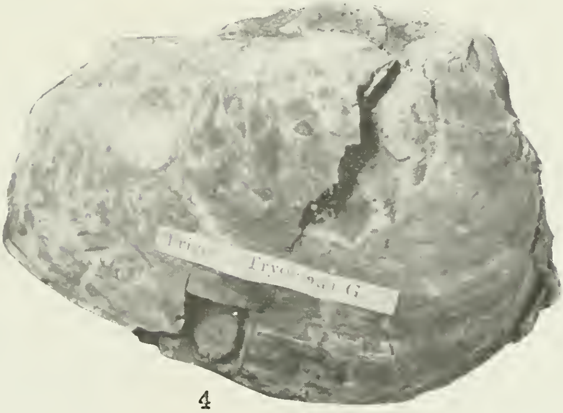

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PLATE 5

All figures approximately natural size

Figure 1.—*Trigonia leana* Gabb. Reproduction of original figure of the type. Upper Cretaceous, Chico group of Martinez, Contra Costa County, California.

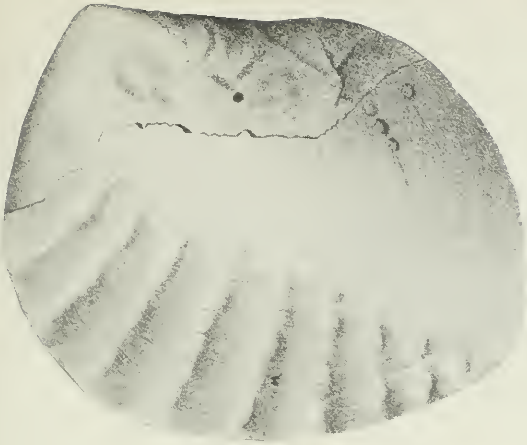
Figure 2.—*Trigonia leana* Gabb. Immature specimen from Rock Creek, Wheeler County, Oregon.

Figure 3.—*Trigonia leana* Gabb. Reproduction of immature specimen figured by Gabb.

Figure 4.—*Trigonia leana* Gabb, var. *whiteavesi*, n. var. Specimen numbered 12123. California Academy of Science, from Pescadero, San Mateo County, California.

Figure 5.—*Trigonia leana* Gabb. Ovate form from University of Oregon, locality 56, Medford, Oregon.

Figure 6.—*Trigonia leana* Gabb. Specimen labeled as "T. gibbonana" in the Condon Museum, from Jackson County, Oregon.



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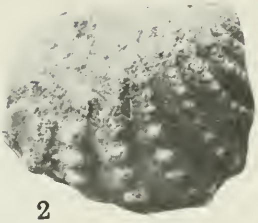

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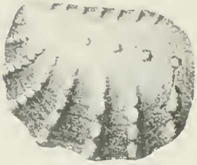

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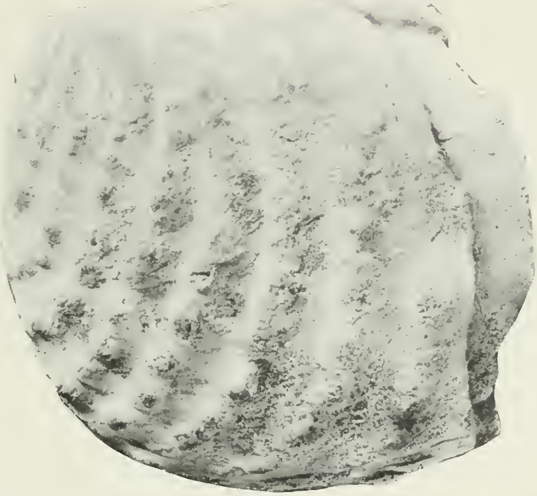

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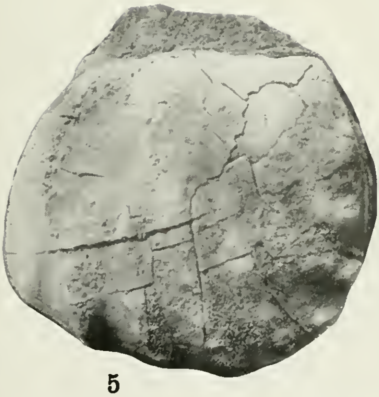

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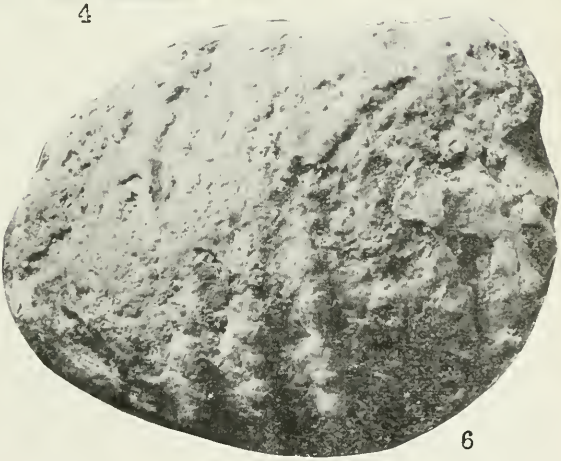

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PLATE 6

All figures approximately natural size

Figure 1.—*Trigonia leana* Gabb. Internal mold of specimen from University of Oregon, locality 88, Crooked River, Oregon.

Figure 2.—*Trigonia leana* var. *whiteavesi* n. var. Reproduction of original figure by Whiteaves of an unnamed form from the Haida Cretaceous, Queen Charlotte Island.

Figure 3.—*Trigonia fitchi*, n. sp. Type specimen. Upper Cretaceous, Chico formation of Griffin Creek, Jackson County, Oregon.

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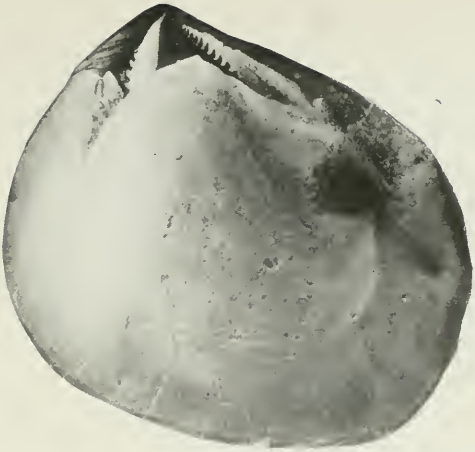

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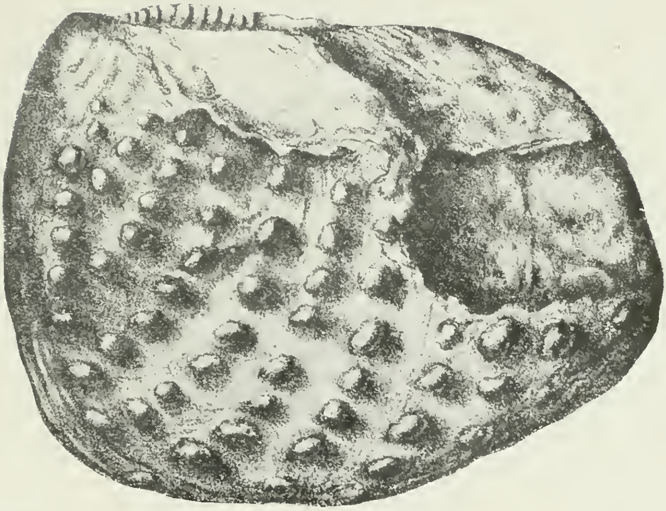

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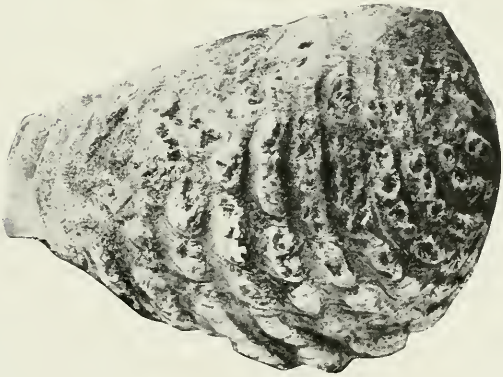


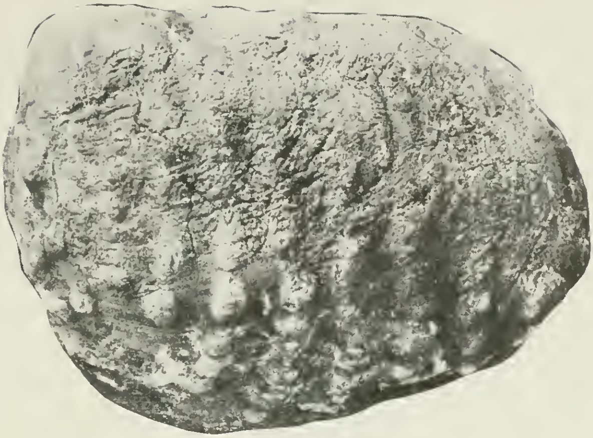
PLATE 7

All figures approximately natural size

Figure 1.—*Trigonia leana* Gabb. An elongate form from University of Oregon locality 92, Rock Creek, Wheeler County, Oregon.

Figure 2.—*Trigonia fitchi*, n. sp. Cotype from University of Oregon locality 98, Ager, Siskiyou County, California.

Figure 3.—*Trigonia flexicostata* Burwash. Reproduction of the original figure of the type. Upper Cretaceous, Haida formation of Maude Island, Queen Charlotte Islands, B. C.



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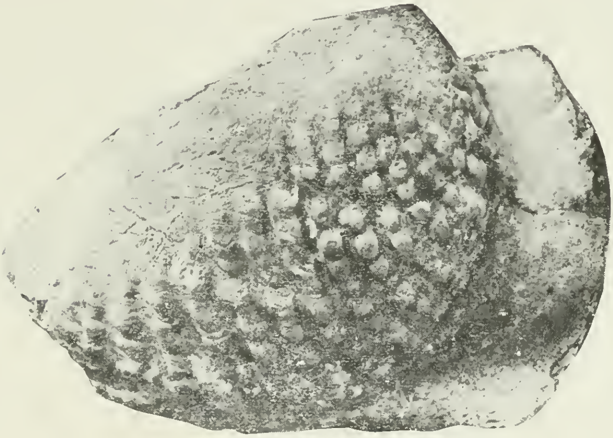

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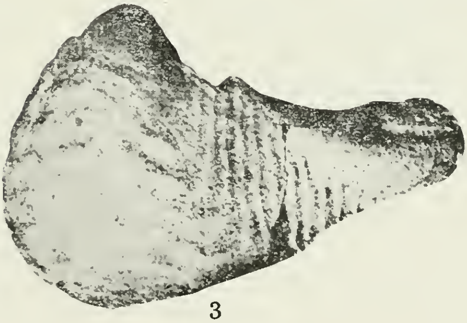

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PLATE 8

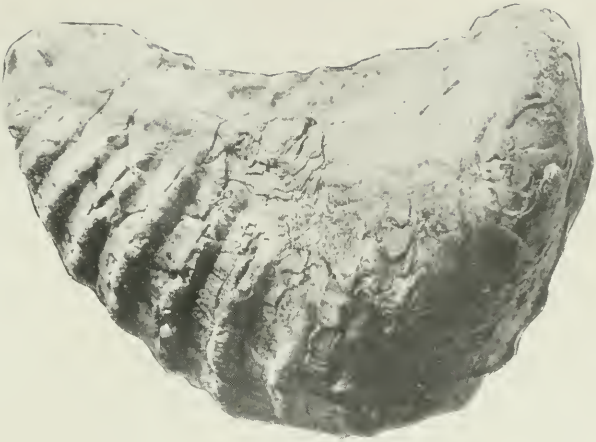
All figures approximately natural size

Figure 1a.—*Trigonia inezana*, n. sp. Type specimen, Santa Ynez Mountains, California.

Figure 1b.—*Trigonia inezana*, n. sp. Same specimen.

Figure 2.—*Trigonia condoni*, n. sp. Mold of type specimen. Upper Cretaceous, Chico group, near Grants Pass, Josephine County, Oregon.

PLATE 8



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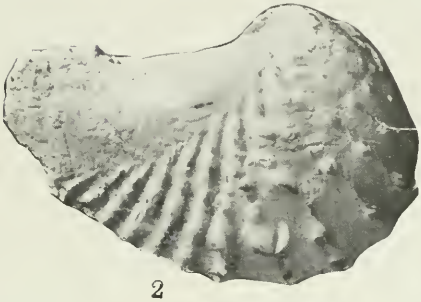

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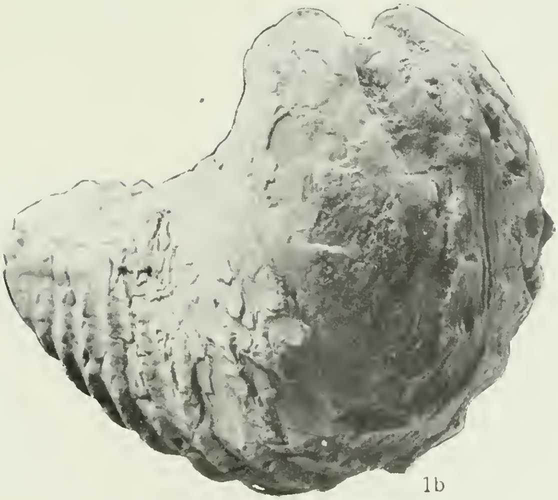

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PLATE 9

All figures approximately natural size

Figure 1.—*Trigonia inezana*, n. sp. Type from upper Cretaceous of Santa Ynez Mountains, California.

Figure 2.—*Trigonia maudensis* Whiteaves. Reproduction of the type specimen, Upper Cretaceous, Haida formation, Maude Island, Queen Charlotte Islands, B. C.

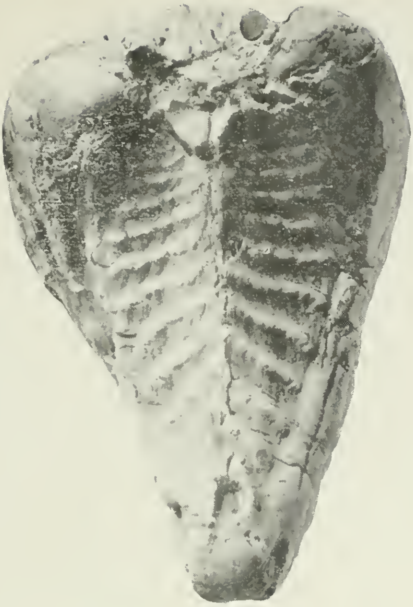
Figure 3.—*Trigonia aequicostata* Gabb. Reproduction of the original figure of the type. Upper Cretaceous, Horsetown beds of Orestimba Canyon, Contra Costa County, California.

Figure 4.—*Trigonia newcombei*, n. sp. A specimen obtained from Skidegate Inlet, Queen Charlotte Islands, B. C.

Figure 5.—*Trigonia evansana* Meek. Reproduction of the original figure of the type. Upper Cretaceous of Nanaimo, Vancouver Island, B. C.

Figure 6.—*Trigonia evansana* Meek. Reproduction of the original figure of the type. Upper Cretaceous of Nanaimo, Vancouver Island, B. C.

Figure 7.—*Trigonia evansana* var. *oregana*, n. var. Mold of type specimen. Upper Cretaceous, Chico group of Crooked River, Oregon.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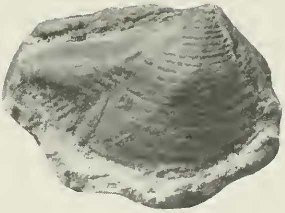
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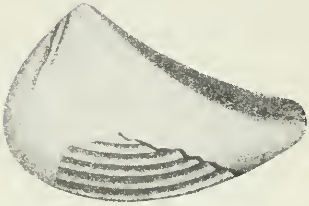
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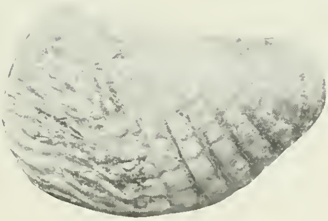
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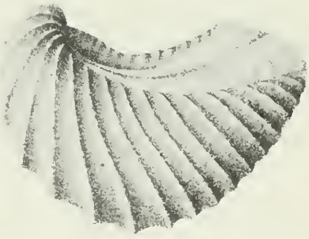
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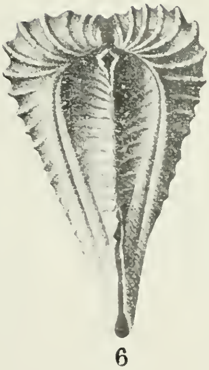
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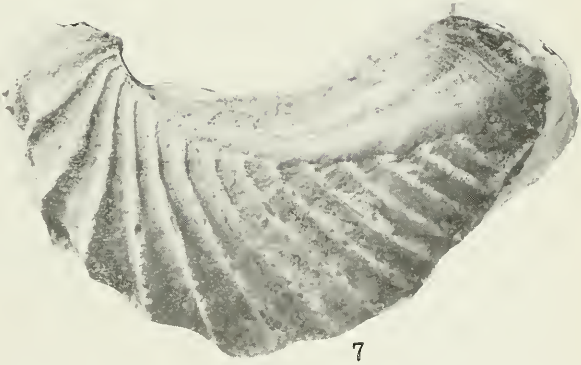
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PLATE 10

All figures approximately natural size

Figure 1.—*Trigonia inezana*, n. sp. Chico Creek, Butte County, California.

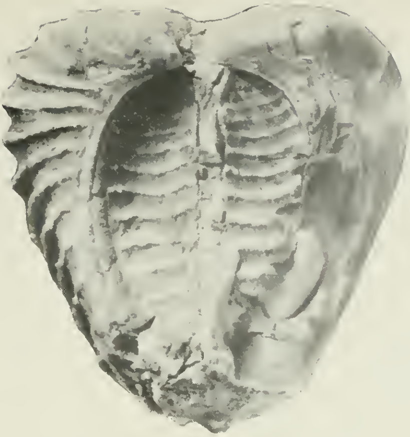
Figure 2.—*Trigonia newcombei*, n. sp. Type specimen. Upper Cretaceous, Haida formation of Skidegate Inlet, Queen Charlotte Islands, B. C.

Figure 3.—*Trigonia deschutesensis*, n. sp. Type specimen. Upper Cretaceous, Chico formation of Crooked River, Oregon.

Figure 4.—*Trigonia newcombei*, n. sp.

Figure 5.—*Trigonia plumasensis* Hyatt. Lectotype, Middle Jurassic, Bicknell sandstone. Taylorsville, California.

Figure 6.—*Trigonia newcombei*, n. sp. Same locality as that of figure 2.



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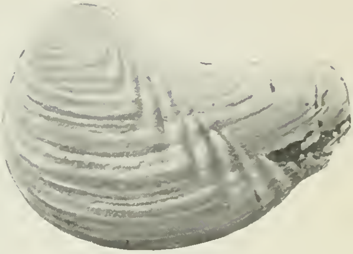

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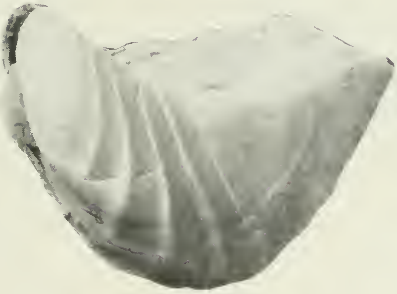

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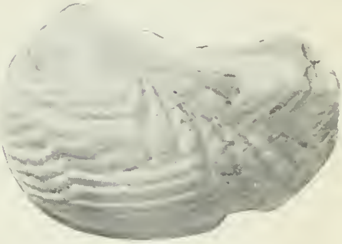

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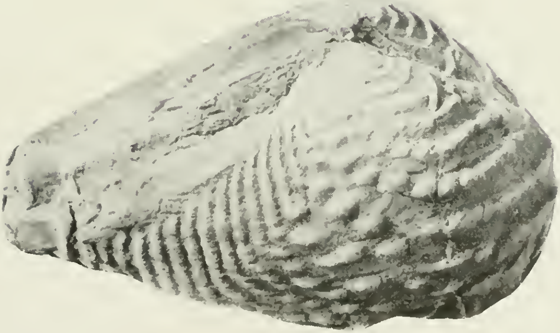

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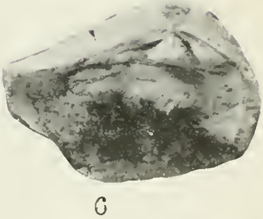

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PLATE 11

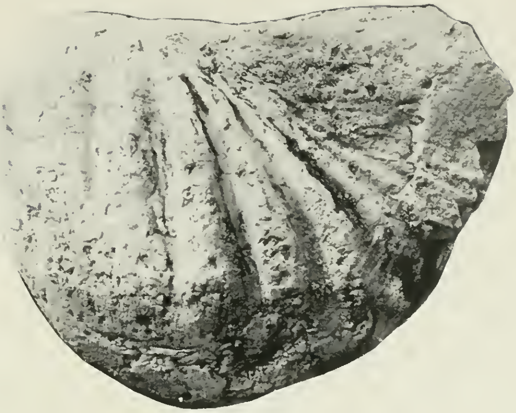
All figures approximately natural size

Figure 1.—*Trigonia columbiana*, n. sp. Type specimen. Upper Cretaceous, Haida formation, Queen Charlotte Islands, B. C.

Figure 2.—*Trigonia newcombei*, n. sp. Specimen from Newcombe collection from Skidegate Inlet. Queen Charlotte Islands, B. C.

Figure 3.—*Trigonia columbiana*, n. sp. Drawing by Rachel Husband, based upon several specimens from University of Oregon locality 104, Skidegate Inlet, Queen Charlotte Islands, B. C.

Plate 11



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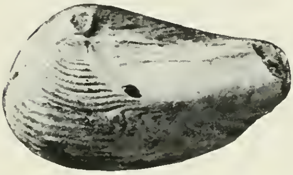

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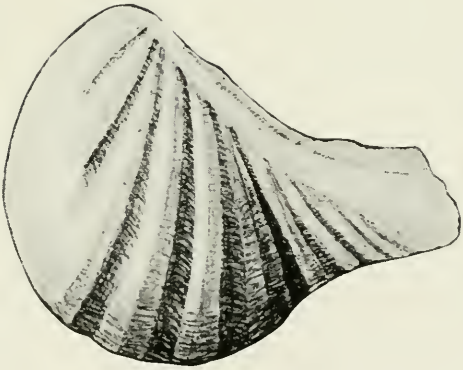

3

THE SYNAESTHESIA OF A BLIND SUBJECT WITH COMPARATIVE DATA FROM AN ASYNAESTHETIC BLIND SUBJECT

BY

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and

THOMAS D. CUTSFORTH

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The Synaesthesia of a Blind Subject with Comparative Data from an Asynaesthetic Blind Subject*

1. General Introduction

In a recent monograph (11) the senior writer reviewed the general subject of synaesthesia and described a very complicated case in a blind reagent. In that investigation it was found that the reagent not only associated a color or a certain degree of brightness with every sensory experience other than the visual but also that these same colored associates invariably appeared in his processes of thinking wherever imagery was employed. The investigation here reported is largely concerned with a description of these analogous associations in certain of the higher intellectual processes.

Out of the vast amount of literature on synaesthesia we find very little mention of the existence of synaesthetic phenomena in connection with mental processes other than that of perceiving. In no instance has a case in the realm of thinking been fully described. In fact we do not know to what extent, in the same individual, synaesthetic phenomena appear both in perceiving and in thinking. So far as our knowledge goes no case has ever been reported in which colored associates or allied associated imagery appeared in thinking but not in perceiving. There seems to be good reason for believing that where such phenomena appear in perceiving, they likewise occur in thinking and that the failure to report this fact, generally, in the literature on synaesthesia has been due to superficial investigations of the phenomena.

A survey of previous studies in this subject reveals the following generalizations:

1. Synaesthesia consists of the appearance of a certain stereotyped image with a given sensory experience. The phenomenon exists in a variety of forms the most common of which is

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*The term "asynaesthetic" is used throughout this monograph to mean non-synaesthetic. We are indebted to Professor Edwin G. Boring for suggesting this term and likewise for carefully reading the entire manuscript. To him we wish to express our gratitude for many valuable suggestions and criticisms. We are also indebted in no small degree to Professor Lewis M. Terman who read the manuscript and made many valuable suggestions. To Dr. Harold R. Crosland we wish to express our thanks not only for his kind suggestions but for his generous assistance in reading proof.

the appearance of colored visual images in connection with sounds, tastes, smells and tactual experiences. Where tones appear colored, the experience is called colored hearing. The associated image is sometimes called a photism or chromatism. Usually the associated image is derived from a sense modality other than that of the sensory experience itself. The following is a fairly complete list of the known varieties of synaesthesia:

A. Of acoustic origin
  1. colored hearing of tones, noises, chords, melodies, sounds of vowels, consonants, words and the like;
  2. gustatory audition in which tastes are associated with the sounds of words;
  3. figured audition in which geometrical forms are associated with the sounds of words:
  4. pain audition in which tooth-aches or other pain images are associated with tones of a certain quality.

B. Of visual origin in which visual perceptions of lines, forms, figures, letters, digits and words are accompanied by colors.

C. Of gustatory origin
  1. colored tasting;
  2. colored taste, smell and cutaneous complexes.

D. Of olfactory origin
  1. colored odors.

E. Of cutaneous origin
  1. colored pain, pressure, temperature sensations;
  2. colored tactual and kinaesthetic complexes;
  3. auditory pain in which the sensation of pain is accompanied by imagery of a sound.
  4. Auditory-pressure in which sensations of pressure are associated with imagery of sounds;
  5. cutaneous or kinaesthetic taste in which cutaneous or kinaesthetic sensations are accompanied by images of taste.

E. Of kinaesthetic origin in which kinaesthetic sensations are accompanied by
  1. an image of color or brightness;
  2. an image of taste.

G. Of organic origin in which affective or emotional experiences are accompanied by
  1. an image of color or brightness.

H. Personifications or dramatizations of ideas, letters, digits or words.

This classification represents roughly the order of frequency in which the various forms of synaesthesia are found.

2. Much of the experimental work on synaesthesia has been devoted to the task of ascertaining what factors determine the origin, the variety and the behavior of the associated image. No satisfactory conclusions have been reached concerning the origin of synaesthesis although it is generally believed that the phenomenon is congenital. The modality from which the associated image is derived in any one case was thought to depend

upon certain physiological conditions in the brain; and the quality of the associated image was thought to depend, in many instances, upon laws of association. The behavior of the associated image is undoubtedly determined for the most part by the same factors as control the behavior of the original sensation to which the image becomes attached. That is, the associated image appears at once with the primary sensation; it persists as long as does the primary sensation and disappears when the primary sensation disappears; it fluctuates in intensity or varies in quality as does the primary sensation, and so on.

3. While numerous experimental methods have been employed in former investigations of synaesthesia (11, page 34) in no instance was the reagent a thoroughly trained introspector nor were detailed introspections resorted to in an effort to ascertain the laws of the behavior of the associated imagery.

4. Detailed analyses of large numbers of individual cases have revealed alleged evidence in favor of a physiological explanation of the phenomenon in terms of such processes as irradiation or lack of differentiation of function in cerebral centers. Other evidence, however, pointed to an association theory (11, pages 36-39). A combination of these views is highly unsatisfactory for two reasons: (1) It presupposes two radically different species of synaesthesia—a state of affairs which is unwarranted by the facts; (2) neither view does justice to the functional aspects of synaesthesis itself but merely describes the conditions under which the phenomenon occurs. In other words neither view gives us a clue as to what the *act* of synaesthesis *is*. Only casually has it been mentioned that synaesthesis may be a form of *reflex.*

5. The phenomenon itself is relatively rare, appearing in 8-10 per cent of individuals, according to some investigators. We believe, however, that these figures are too high and that 5 per cent or a number slightly exceeding the frequency of color blindness is more accurate. While in certain individuals synaesthesis appears to be of no particular value, in others it has been found a distinct advantage. From time to time attempts have been made to trace the significance of the phenomenon in the poetry of synaesthetic writers (11, page 26); and certain musicians have endeavored to introduce colors in connection

with musical productions (11, page 60) but owing to the fact that most readers on the one hand and auditors on the other have no synaesthetic phenomena of their own and hence do not understand or appreciate them in other people, such attempts have invariably produced negative results. Should synaesthesis be more common it could not be used in the arts for the reason that the phenomenon varies in content and in complexity from individual to individual. There is no uniformity in the quality or form of the image which happens to become associated with a given sound, letter or object.

6. Whether synaesthesis is a unit trait which follows Mendel's law of inheritance has not been ascertained. There seems to be no definite evidence that the phenomenon is inherited. In some instances it appears to run in families but in a greater number of instances it apparently does not. The early origin of synaesthesis in the life of the individual who possesses it points to the fact that the phenomenon is congenital.

7. Synaesthesis is apparently more common among children than among adults. Probably at least 50 per cent of the total number of cases existing in childhood disappear during the mental changes of the adolescent period. In such instances, however, in which the phenomenon persists over long periods of time and in which the individual has been subjected to repeated tests, the striking fact has been revealed that the associations have remained constant. For example where in early childhood a flute tone appears blue, a flute tone will appear that same quality of blue many years afterward. Of what changes take place in synaesthesis during senescence we have no knowledge.

8. Owing to the fact that the majority of recorded cases of synaesthesia have been perceptual phenomena with only a scattered report now and then of similar associations in processes of thinking there has arisen among psychologists a predisposition to regard true synaesthesia as a peripherally aroused process. Since related phenomena do exist in dreams (12) and in processes of thinking (11, page 39) it is evident that more light may be thrown upon the nature of the perceptual variety from a detailed study of the latter. Moreover, in the latter we find that it is an image of the original sensory experience which now has the same colored associate as did the sensory experience itself.

This leads us to the conclusion that ''imaginal synaesthesia'' is derived from ''perceptual synaesthesia'' and therefore has as much claim to the term synaesthesia as its parent phenomenon.

In order to keep these two forms clearly differentiated we shall speak of the perceptual or sensory form, which is peripherally aroused, as ''synaesthesia'' and shall call the same phenomenon, as it appears in the realm of the higher intellectual processes, a ''synaesthetic phenomenon.''

We have here introduced as ''check data'' results from a second *blind* subject who has no synaesthesia of any sort. Thus the data from the synaesthetic subject will be emphasized in contrast with the data from the asynaesthetic reagent.

II. REAGENTS, METHOD, MATERIAL

The reagents in this investigation were Thomas D. Cutsforth, observer *A* and joint author of this monograph; and Leslie C. Blades, observer *B*. *A* is now 28 years of age. He lost his sight by accident at the age of 11. His right eye was at that time so badly damaged that it was removed and an artificial eye was substituted. Sufficient musculature remained, making it possible for the subject to move the artificial eye slightly in any direction. The left eye became inflamed immediately following the accident, and has remained badly out of focus since that time. The left retina, however, was not destroyed and is still slightly functioning, as our preliminary experiments will reveal. *A* graduated from the University of Oregon in 1918. Since that time he has taught in a high school. At present he is a graduate student and assistant in Psychology at the University of Oregon.

Observer *B* graduated from the University of Oregon in 1916 and obtained an A.M. degree in 1917. He lost his sight by accident at the age of 9. He was 25 years of age when his introspective data were obtained.

The data for this investigation are entirely introspective and were throughout obtained under standardized conditions. *B's* introspections were given during the winter of 1916 while the reagent was a major student in the psychology laboratory, and were at that time edited by the reagent himself. In introducing this material as data, here, great care has been exercised in keeping them as closely as possible in their original form.

The introspections from observer *A* were obtained during the winter of 1921. Unless otherwise mentioned, the sets of data from both *A* and *B* were obtained under identical conditions and under similar instructions. The senior writer, throughout, was the experimenter.

After the instructions had been given to the observer and the task had been fulfilled, the observer dictated his introspection in as great detail as possible to the experimenter who wrote it down in full. Then, at times, the experimenter asked carefully worded questions in order to obtain greater detail here and there in the introspective descriptions. All such questions, however, were carefully presented in order to avoid any possible influence of suggestion. Rarely were such questions necessary and in no instance was a leading question asked.

Details concerning apparatus and instructions will appear in connection with the presentation of the data. In general the reagent was instructed to assume a comfortable position in his chair and to prepare himself for the instructions. Such a preparation consisted of assuming a receptive attitude toward the instructions and of waiting for any distracting thought or other minor disturbance to pass away before the instructions were finally presented. The reagent then announced when he was ready whereupon the instructions were read to him. In no instance, unless it was particularly desired otherwise, was the reagent warned in advance as to what the nature of the instructions would be. This procedure was followed in order that the resulting mental processes might be as spontaneous as possible and that they might not be affected by antecedent processes. Each series of experiments was separated from the others either by a period of adequate rest or by performance on successive days.

III. Preliminary Experiments

A. Introduction.

Observer *A* is not totally blind. His vision, however, is confined to a certain form of entoptic phenomenon. While on a clear day when the sun is high and the reflection of light from objects in the environment is at a miximum, *A* can obtain vague glimpses now and then of objects near him. Such vision is very uncertain, is always mingled with visual imagery and entoptic phenomena and never exceeds an area larger than the palm of one's hand. Since such experiences are exceedingly rare we need not describe them in detail. That light does at times penetrate to the retina is confirmed by other facts. If *A's* left eye happens to be turned in the proper direction toward a source of artificial light one corner of a vague visual field is at times dimly and momentarily brightened. Owing to the distortion in the shape and direction of the eye-ball such light as does reach the retina always falls upon the periphery and not upon the fovea. *A's* experiences of seeing, as far as external stimuli are concerned, therefore, are confined to blurred and dimmed peripheral vision.

On the other hand *A* is constantly aware of a "field of vision" before him, which is filled with colors and brightnesses of innumerable varieties of quality, size and form. In order to ascertain if possible whether this was synaesthetic imagery or actual visual sensation, *A* gave complete introspective decriptions of these visual experiences.

B. Typical introspective data on A's entoptic phenomenon.

[Note: The numbers which appear before each introspection are introduced for the purpose of reference. In parentheses ( ) are to be found *A's* own interpretations of his introspections, given during the act of introspecting; in brackets [ ] are to be found the authors' subsequent comments. These comments are intended to bring out the important or highly significant features of the preceding introspective data.]

1. "Outstretched bidimentionally before me at a distance of what appears to be but a few centimeters is a spacial field about as large as one ordinarily sees before him, oval in shape, but with indistinct limits at the periphery. This field is not a flat surface, as if one were looking at a sheet of paper, but resembles, I think, what one would 'see' if he suddenly entered a dark room, so far as depth is concerned. This field is filled with changing colors and brightnesses which are shifting about in kaleidoscopic fashion.

At one instant these colors and brightnesses are irregular blotches which are constantly changing in size, shape and outline. They change so rapidly that it is utterly impossible to describe them in minute detail. The center of this visual field tends to be dominated by yellows, 'pinks,' reds and light greens. The next instant these colors become streaks or 'spatters,' as if they had been sprayed upon some invisible surface, and what corresponds to this surface is a background of changing greys, sometimes real dark, or almost black, and sometimes more of a neutral grey. The background itself is constantly changing in brightness. Farther out from the center of this visual field are darker greens, bluish greens and blues, and still farther, toward the periphery, are dark and very poorly saturated 'bottle' greens or 'navy' blues until, at the very edge, colors and forms alike become indistinct, duller and darker, merging into nothing but shades of black. Again, colors may entirely disappear momentarily and the entire field becomes a mottled grey. At times there appear very suddenly, covering the entire field, fine networks of white or yellowish streaks which resemble flashes of lightning. These flashes whirl about and constantly change their position and direction. Then again I see powdery whirls of fine, grey specks on a darker background, or dark specks on a lighter background, the whole visual field becoming a seething mass of 'molecular-like dust.' There are no reds beyond a limited area in the center of the field; there are no colors in the far periphery. The whole field is characterized by rapidity of change in color and brightness, by sudden and continuous shiftings in the form, shape and outline of the colored areas. All the colors and brightnesses appear the same distance from me and since they are constantly changing in shape and quality hardly ever are there any distinct outlines to these forms. (I believe that they resemble spatterings of of different water colors or shades of black and white as they would appear if painted at random upon a wet surface, upon which the different colors and brightnesses would 'run' together.)"

The following is an account of *A's* remembrance of this phenomenon which extends back to the years 1904 and 1905:

2. " It was in the winter of 1904 that I first noticed this phenomenon and it was during the time that my left eye was recovering from its inflammation. I used to sit by the hour and watch these changing colors and I noticed, at the time, that physical exertion brightened the colors and made them more variable. (This was evidently due to changes in circulation which resulted from physical action.) As I recall the colors as they appeared then, I think that the blotches and irregularly colored areas were at that time larger than they are now and there were larger areas of grey between the colors. Now the forms are smaller and more thickly distributed with resulting smaller areas of grey background."

[Introspection (1) resembles so closely other introspections on this phenomenon that additional data is unnecessary. It is interesting to note that the distribution of colors in this visual field described by *A* corresponds to the distribution of colors in the retinal zones. Reds and greens appear only at or near the center of this visual field; blues and yellows appear toward the periphery and beyond the reds and greens. At the very margin of this visual field there appear only greys and blacks. White streaks may be distributed over the entire field, or at least very close to the margin. This distribution of colors and brightness suggests at once that the phenomenon is sensory, and peripherally aroused.]

C. Conclusions concerning A's entoptic phenomenon.

These introspections describe almost exactly the phenomenon which the normal seeing person can at any time observe when he closes his eyes and presses upon the eye-balls. One often observes this same phenomenon when he suddenly enters a dark room. It is quite evident, therefore, that *A* has described a form of entoptic phenomenon which is so common that one need not discuss the literature on the subject. The retina possesses a slight amount of ''inherent'' light of its own, associated perhaps with the ''visual purple'' or purple pigment which lies adjacent to the rods and cones. It is this faint, inherent light which one ''sees'' as ''black'' when he enters an absolutely dark room; and it is because of this inherent light in the retina that under conditions of mechanical stimulation by means of pressure, circulatory changes and the like, one sees colors and varying degrees of brightness, although the eyes are closed or external light is prevented from reaching the retina. This entoptic phenomenon belongs to the class of ''muscae volitantes''.

The following facts concerning observer *A's* entoptic phenomenon justify us in concluding that he actually sees colors and shades of brightness.

1. The colors and brightness are distributed, in the visual field, according to the distribution of colors in the retinal zones.
2. The phenomenon is continuous in waking life and only by not attending to it can *A* avoid ''seeing'' it.
3. It is possible to distinguish the behavior and localization of visual imagery from the behavior and localization of the colors and brightnesses of this entoptic phenomenon. Visual imagery may be localized, at will, in front of or behind this entoptic field of vision.
4. The entoptic field of vision is not subject to voluntary control other than as an object of attention. *A* cannot change the forms or colors at will except by employing mechanical means such as pressure upon the eye-ball and under such circumstances the changes are fortuitous so far as voluntary control of the colors themselves is concerned. He cannot cause these colors to appear or disappear except as they tend to become changed by resorting to mechanical means such as pressure upon the eye-ball or eye-movement.
5. The phenomenon has now persisted for 17 years and with the exception mentioned in introspection number 2, it has not changed in the meantime.

6. *A's* retina is subject to constant pressure from within. The shape and position of the eye-ball reveal some evidences of "scar tissue" or other growths which would provide such a presure.

7. Sufficient rays penetrate the eye to keep the retina constantly supplied with inherent light. This conclusion is derived from the fact that when *A's* left eye is in a certain position with reference to a brilliant light, one corner of his peripheral field of vision is dimly and momentarily brightened.

8. *A's* introspections reveal the usual differences between visual sensations and visual imagery:

a. The forms and colors of the entopic phenomena always appear at the same distance from his eye; there is a regularity, constancy and "firmness" or stability about them which visual imagery ordinarily lacks.

b. The forms and colors cannot be projected or localized at will as is characteristic of visual imagery; for example, *A* can project visualized colors or objects behind him but the relative position of this visual entoptic field never changes.

c. *A* can attend to this phenomenon together with visual imagery and is able to note, introspectively, the differences in behavior, quality and localization of the two groups of visual phenomena.

d. If the visual imagery is faint or fleeting entoptic phenomena may claim *A's* attention to the exclusion of the visual imagery; if the latter be vivid or persistent *A* is able to ignore the entoptic field.

e. The greys of the entoptic field function as a background for most of *A's* visual imagery.

9. The fact that *A* actually sees brightnesses and colors accounts for the fact that he is able to describe colors and shades of grey with remarkable accuracy after 17 years of practical blindness; it also explains why visual imagery has retained its vividness and minuteness of detail as far as qualities are concerned. It may also account for the fact that his synaesthetic phenomena, which are invariably visual, have persisted undisturbed by blindness over 17 years of time.

We feel justified, in view of the above facts, in concluding that *A's* visual imagery which functions in his synaesthetic phenomena is not to be confused with his entoptic phenomenon. The colors and brightnesses in his synaesthetic processes are definitely images and not sensations. They appear and disappear as do ordinary visual images unless their behavior is controlled by the behavior of the primary auditory or tactual sensation of which they are the accompaniments.

D. *The behavior of A's synaesthetic visual imagery compared with the behavior of his sensory entoptic processes.*

To ascertain whether or not *A's* entoptic phenomenon might exert some influence on the functioning of his visual synaesthetic processes when both appear in consciousness at the same time, a series of tests was made in which the reagent was instructed to attend to the colors of his visual field and to be in readiness to report what happened to this visual field when synaesthetic visual imagery was aroused. This procedure was also undertaken for the purpose of discovering whether *A* ever confused his visual sensations with his synaesthetic visual imagery.

The following introspection is typical and resembles so closely a mass of introspective material on this point that only one is here introduced. While the reagent was attending to the colors and brightnesses of his entoptic field the experimenter placed a piece of cold metal upon his head just to the left of and above his left eye. The reagent did not know in advance what stimulus was to be applied.

3. "I was attending to a particular splotch of poorly saturated red near the center of my field of vision and was non-focally conscious of changing colors and brightnesses over a much wider area when my attention was suddenly claimed by some object touching my forehead and by a widespread muscular response of flinching. This latter reaction was distributed about the shoulders, neck, chest and facial muscles; (I was evidently surprised at being touched on my forehead and was reflexly shrinking from the sudden stimulus.) Up to this time I was totally unaware of what object had been applied and totally unconscious of the fact that the stimulus was cold. After my attention had momentarily lingered upon this widespread motor reaction, I found my line of regard fixated upon the upper left hand section of my field of vision, which suddenly became flooded with white light. I actually detected the light as it came in and occupied for a moment the area of my visual field which had but a moment before been filled with indefinite streaks and spots of faded colors or different shades of grey. Simultaneously with this appearance of a brilliant white light which claimed focal attention, I was dimly aware of the remaining portion of my field of vision and here the kaleidoscopic forms and colors were still persisting. I noted that the brilliant light was slightly nearer my face than the entoptic sensations. I noted also that the colors in the upper left hand section of my visual field vanished or gave way to the white light

as if the light itself had been a cloud-like curtain which had suddenly rolled down in front of the existing colors. I could not see the entoptic colors or forms behind the white light; they had 'melted away'; the white light itself was stable, constant and stationary until the experimenter took away the cold object from my forehead. At no time was I focally aware of the coldness of the metal as such." [The cold metal was applied to *A's* forehead for an interval of three seconds. The nearness of the white silvery light which was associated with the coldness of the stimulus was evidently due to the fact that the area selected for stimulation was adjacent to *A's* left eye. The shape, brilliance and persistence of the synaesthetic image correspond to analogous features of the stimulus. It was found that when auditory stimuli were used the source of which was a meter or more from the reagent, the synaesthetic imagery was invariably localized farther out in space, *i.e.*, beyond the localization of the entoptic colors. But in every instance synaesthetic imagery seemed to flash in or roll into *A's* visual field, at once taking the place of the entoptic sensations, wherever the two tended to occupy the same area.]

Thus it is evident that entoptic phenomena constitute one set of visual experiences and that synaesthetic processes constitute an entirely different group. The first is sensation and the second is image. One can best envisage how *A* is able to ascertain the difference, introspectively, between colored visual imagery and colored entoptic phenomena, by trying to visualize an object or a landscape with his eyes shut, noting at the same time what becomes of the blackness which he "sees" when his eyes are closed. Moreover, it is a matter of everyday experience for the normal sighted person to visualize with his eyes open without confusing visual imagery with visual sensation. We can dispel all doubt, therefore, that the visual imagery which *A* describes in his processes of thinking is not a confused interpretation of his entoptic processes.

E. Summary of preliminary experiments.

a. Observer *A* is not totally blind. With his left eye he "entoptically" sees colors and brightnesses.

b. These colors and brightnesses are sensory experiences and are definitely distinguishable from visual imagery.

c. Our reagent in no way confuses his visual imagery with these entoptic phenomena when the two sets of visual processes are simultaneously present in consciousness.

d. *A's* visual synaesthetic phenomena are visual images and are not to be confused with entoptic processes, although the latter may have played a rôle during his 17 years of blindness, in preventing the former from changing or from decaying.

IV. Results From Main Experiments

A. *Series 1.*

a. *Visual imagery.*

i. *Typical introspective data.*

[Instructions: " Think of a bunch of white rosebuds lying among fern leaves in a florist's box."]

4. *Observer A.* " As soon as the experimenter read the instructions there at once appeared visual imagery of a small bouquet of ivory-white rosebuds about one-third opened, lying in a box, with the tips of the buds pointing to the right. The details of the buds—the shape, the curling of the petals, the qualities of the whiteness, etc.—stood out very distinctly, although outlines were not sharply defined. When the experimenter said 'ferns' I found my attention shifting from this visual imagery of the buds to a region slightly to the left and below them, where I visualized a mass of green, with merely a dark streak or shadow here and there, giving the imagery a 'netted' appearance; I saw no other details of the ferns. I then found myself anticipating the word 'box' in verbal imagery and visualized the front side and one end of a box very distinctly; the box was about three inches in height, but further details of shape and size were fleeting and vague; I saw nothing of the box at its other end, nor did any of it appear through or behind the rosebuds and ferns. At that time I did not build out stems or thorns, nor did I have any tactual or kinaesthetic imagery. The visual imagery appeared in a visual setting. The box of roses was lying on my study table in Friendly Hall but I did not see distinctly any details of the table; beyond the table I saw a dark grey background which tended to differentiate into an open window at the left. There then followed fleeting visual imagery of books but at this juncture I recalled the instructions and began to introspect."

5. *Observer B.* [Same instructions as for observer *A* above.] "As the experimenter read the instructions I was first aware of very fleeting, indefinitely outlined visual imagery of the buds, which were opaque white, not clear but diffuse and 'creamy'; but hardly had this visual imagery appeared when it gave way to tactual imagery of handling soft, spongy buds. I paused and tried to revive the visual imagery again but my efforts were unsuccessful. The buds as I visualized them were lying on something, but what I do not know for there was no visual or other imagery of any object near or beneath this visual imagery; I could obtain no visual imagery of the box nor of the ferns; what might have been a box was a very faint, shadow-like form, somewhat rectangular in shape in that it was longer than it was wide, but the object had no top or no bottom. (This vague, sketchy and fleeting shadow I interpret as a visual image of the box.) The buds lacked detail; I saw in them no outline or superposition of petal. This visual imagery had no setting other than tactual and kinaesthetic imagery which tended at once to claim the focus of my attention; the buds and shadow-like box appeared in a fashion, I presume, as a sighted person might visualize something back of his head in the visual 'nothing' that is there. I then found myself trying to revive this shadow-like visual imagery of the box. I succeeded in obtaining a second shadow, this time slightly brown, which turned to a color darker than that of a brown, but which I cannot label; the surface of this shadow presented a veneered or glossy appearance and was motley as regards light and shade. This shadow soon dwindled to areas which would have been the edges of the box had I touches the object which I was trying to visualize. Then there appeared visual memory imagery of boxes which I had seen as a child, mingled with tactual imagery of running my fingers along the edges and about the corners; together with this mixture of tactual and visual imagery there reappeared fleeting visual imagery of white buds and vague shadow-like forms which represented leaves; here, in connection with this tactual imagery, the visual processes

tended to become more stable and persistent. But very shortly this visual imagery gave way entirely to tactual and kinaesthetic processes. [Tactual and kinaesthetic imagery will be described in detail in a later section of this monograph. It is interesting to note that observer *B* obtains visual imagery with great difficulty and that only when ushered into consciousness or accompanied by tactual and kinaesthetic processes is his visual imagery even approximately stable or persistent. Note also the great contrast between *B's* visual imagery and that of *A*, whose visual imagery of rosebuds was described in introspection 4.]

[Instructions: "Think of some person who is well known to you; try to visualize that person and then dictate your introspection."]

6. *Observer A.* "(I visualized Professor *O.*, whom I have not seen for four years.) First there appeared visual imagery of his forehead and ears as he stood several feet away and facing me; then there appeared fleeting glimpses of his nose and chin. His skin was colored a washed-out yellowish tan (the color of his voice); in this imagery there was no continuity of features between his ears, nose and chin; between these isolated portions of his head was the setting or background of dark grey on which I find myself habitually projecting my visual imagery. After this imagery had appeared and was still lingering in consciousness his mouth 'filled in' between the nose and chin; I then saw that his mouth was opened slightly as if he were speaking; then beneath his chin there appeared portions of his neck, particularly the region which is ordinarily visible above a white collar and in this imagery his 'Adam's apple' stood out prominently. While all of this imagery appeared in rapid succession and with a relatively high degree of clearness it was the general shape and the color of these features which stood out rather than distinctness of outline and detail of shape. The imagery appeared diffuse in those regions which might otherwise form definite lines or edges. (I suppose in this respect my visual imagery resembles the blurred condition of a composite photograph made from exposures of several people on the same plate.) I found it impossible to connect these isolated facial features into one continuous visual image. As this scattered imagery lingered, I then saw teeth showing in the slightly opened mouth; the teeth which stood out the clearest were particularly those lower teeth which would ordinarily but barely show when one is talking. Curiously the lower middle teeth were indistinct; the teeth which became definitized in this visual image were those which lie on either side of the center. My attention was then claimed by fleeting auditory imagery of his voice, accompanied by focal flashes of yellow light—the same color as appeared in my visual imagery of his face and the color which always identifies for me the quality of his voice. This was all of the imagery which I obtained at first and which followed immediately upon my hearing the instructions. This imagery appeared in space at a distance interpreted to be about 14 feet. I then filled out in visual imagery, still in the yellow color of his voice, other parts of his body, including the general shape and outline of his body in a sitting position. Here again I could not see more than a limited portion of him at any one time but as I shifted my line of regard from one part of this vaguely isolated form to another I more definitely pictured his shoulders, then the bottom of his sack coat and from that region I shifted to the bottom of his trousers. With each shift of visual attention I was aware of slight eye movement together with the fact that my fixation point had changed. At no time during the entire process did I have any tactual imagery of touching him nor any kinaesthetic imagery of feeling of his clothes. (The chief features of my visual imagery consisted of their patchy character with areas of a dark grey setting between these patches, and the yellowness of the imagery. I have made the general observation with respect to my visual imagery that I do not tend to shift from visual to tactual or kinaesthetic processes unless the object which I am visualizing is one which I have recently handled in tactual-kinaesthetic fashion.)"

7. *Observer B.* Same instructions. "(I have been trying for several seconds to visualize my old room-mate, but for the most part my efforts have been unsatisfactory.) There first appeared very indistinct and fleeting visual imagery of his forehead, temples and eye-regions, about life-size and colored a vague, dim white. I could not obtain visual imagery of all of these features at one time; I could see no hair, no neck and no ears and I could not distinguish the color of his eyes. In every instance the imagery was photographic and lacking in definiteness of form and outline. The only features which approached definiteness were the facial dimensions of the temples. (I notice that every feature which I have been visualizing is one which I have observed tactually.) Along with the above imagery I had tactual and kinaesthetic images of the smoothness and texture of his skin, and visual imagery now became confused with this tactual and kinaesthetic awareness. For example, my visual images of his nose and chin were confused with tactual-motor images of running my fingers over these facial features. Then upon further effort I was able to conjure up added vague and fleeting visual imagery of a collar and neck-tie, but I am not certain whether this is imagery which ever functioned in connection with memories of my room mate. The collar is white but it is only a mere suggestion of whiteness in the form of a streak localized under a similarly fleeting chin. I saw no color in the tie, for it was merely a shadow-form, broader at the bottom than at the top. None of this visual imagery appeared in a visual setting and while it was localized in space rather close to me the setting was entirely tactual and kinaesthetic."

[Instructions: Visualize some familiar scene or landscape.]

8. *Observer A.* "(I have visualized a certain turn in a country road which I saw in childhood and have not visited since that time.) Looming up before me in space and in what appeared to me to be normal dimensions was a road which extended upward over a very steep grade and through a deep cut. I first saw the flat road at my feet, where the wagon tracks in the sand stood out as the most prominent features; then my attention shifted, visually, to the walls of the cut, which were about shoulder-high; here very little detail stood out, for I saw only the smooth grey walls of sandstone, with here and there a shadow or broken place in the banks, represented by areas or streaks of darker grey. (This I interpreted as meaning the places in the banks where the frost had broken off some of the rock.) I saw no strata nor any details of individual pieces of rock; I saw no details of gravel or of vegetative growth on the sides of these walls. The entire visual image, so far, was a washed grey, but the scene appeared in its proper perspective, *i. e.*, I saw the road becoming smaller and smaller as it approached the top of the cut and noticed the walls of the cut coming closer and closer together the farther away I visualized them. The sand of the road and the walls of the cut were the same color—a grey, slightly tinged with yellow. Then there developed, on each side of the cut, visual imagery of scrub oaks with dead autumn leaves hanging from the tips of the branches; there then appeared autumn leaves scattered over the ground beneath the trees. The uppermost portions of the trees faded into nothing. I saw no line or skyline. As this imagery persisted and I found my visual attention wandering from one detail to another, I noticed that it was tri-dimentional, i.e., I saw parts of trees extending back and behind the trees which were in front. The leaves on some of the nearer trees now developed here and there into relatively clear-cut forms and outlines, but I still visualized the distant leaves as mere dashes or 'daubs' of brown. The leaves on the ground remained, throughout, areas of mottled or speckled brown with definite outlines of only one or two individual leaves here and there. In each instance I found that the definitely outlined leaves were those upon which I was directly fixating my visual line of regard. As to the trunks, I visualized their general form and size but was not aware of minute detail of bark or color. (I can, however, construct visual imagery of tree trunks in which there appears a wealth of detail even to the nature of the bark and various vegetative growths such as moss and lichens.)"

9. *Observer B.* Same instructions. "(I visualized a scene at Cripple Creek, where I lived as a boy before my accident.) I first obtained a very sketchy visual image of the first school which I attended and of the Catholic church which stood behind it. The only distinct features of this imagery consisted of the bronze railing around the roof of the school building and the windows of the upper story, in front, as one would view them when standing in the street below. Accompanying this visual imagery was very distinct kinaesthetic imagery of eye-movement and strain of eye fixation upon the object visualized. There then appeared in very sketchy and fleeting fashion visual imagery of a dark, green mountain range which loomed up in the background beyond the school, and beyond the mountain was a faint suggestion of blue sky. All of this latter imagery was momentary and appeared like a tachistoscopic flash and was gone again. I found that I could revive it only by concentrating my visual attention again upon the bronze railing of the schoolhouse. Thereafter further attempts to retain this visual imagery resulted only in masses of kinaesthetic and tactual imagery. (I find that I am totally unable to visualize a neck-tie or other object either in this green or in this blue which momentarily appeared in my visual imagery. The colors have vanished and I cannot reinstate them.)"

[Instructions: Visualize a printed word.]

10. *Observer A.* "(I visualized the word 'the.') I was at once able to construct fairly satisfactory visual imagery of the three letters, *t, h,* and *e,* in print. They were not, however, printed upon any particular material or surface; they appeared in a visual setting consisting of that neutral grey background which so often surrounds my visual imagery. The 't' was a small letter, not a capital, the form and outline of which were very distinct, and were colored a reddish brown of only a poor saturation—the same reddish brown which always means 't.' The 'h' lay on the same background as the 't' and next to the 't' on its right, but this imagery was so faint as almost to merge into the grey of the visual setting; the form or outline of the 'h' was equally as indistinct as the color. Then I very clearly visualized the 'e' lying just to the right of the 'h'; it was the most distinct of all the letters and was likewise the most brilliantly colored. In fact, the color was the most distinguishing feature of the 'e' and that feature which dominated consciousness when I was attending to the letter. The exact shape of the curved lines which constituted the 'e' was the least clear of any of its features. (The color and brightness of the letters were the same as they always appear whenever I have verbal imagery or perceive these letters in any fashion.) After this imagery appeared I then set about attempting to visualize these letters printed in black ink. I found that I could thus visualize them in the type which is used in a child's primer; the letters resembled those which are emphasized in heavier print in order to represent the silent letters of a word. These letters appeared at about a reading distance from me. Hovering about the 'E,' which was the least clear of any of this visual imagery, was a halo of the same bright color which appeared in my previous visual imagery of that letter; this color identified the letter as 'E'; the printed 'E' looked as if the surface on which it was printed had slipped just as the 'E' was being stamped upon that surface—it was blurred and the outlines of the letter were ragged. The form and outline of the 'T' stood out fairly plainly in this latter visual imagery but were tinged with the same color as appeared in my previous imagery. The 'H' was again very indistinct and tended to merge, as before, into the grey setting. (The color for 'H' closely resembles the grey of the visual setting, which explains why it is not clearly distinguishable from the background.) The setting for this latter imagery was identical with the previous visual background. The longer the imagery persisted, the more the form and outline of the letters tended to give way to increasing clearness in the colors which aways stand for these letters. I found it impossible to make the letters remain black."

11. *Observer B.* Same instructions. "(After trying for some time to follow the instructions I reported that I could not visualize printed words.) Upon trying for some time to fulfill the instructions I found that my efforts resulted only in obtaining tactual-kinaesthetic imagery with only vague suggestions now and then of visual imagery in connection with a visual-kinaesthetic and schematic spacial image. I found myself having a wealth of tactual-motor imagery of writing my name in script, which I often practice in order not to forget it. If I eliminate this tactual-motor imagery I am able to obtain vague, fleeting schematic visual-manual-motor imagery of my name as if it were being written by an invisible hand. I also find imagery with incipient eye-movement of following what I remember, vaguely, to be the general shape of the letters, but I am unable to visualize anything where the invisible pencil has just traversed—no pencil, no hand, nothing except the spacial and schematic movement of tracing the form of the letters. I found that I could visualize a vague point or spot along the outline of the letter, which moved continuously over the letter, but the space over which the moving point had just traversed disappeared as the point moved on to another position. Thus the letter disappeared as fast as it was formed. All of my imagery was tactual or motor except the spacial representation of a point along the letter as it was being written. Peculiarly, this point did not move upon a visualized surface; it merely moved, that is all. (Thus I fear that my visual imagery of letters is but a visual-kinaesthetic-schema.)"

[Instructions: Visualize a cube.]

12. *Observer A.* "I was able to distinctly visualize a cube, the edges of which were about three inches long; it was localized in space, about at arm's length, and directly in front of me; in this imagery I saw at one glance the surfaces which are ordinarily visible when one corner—here an upper corner—is directly in front. My line of regard was fixated upon this corner. Extending definitely in three different planes were the upper surface of the cube, a more or less broadside view of the front surface, and the diamond-shaped right side, appearing in perspective. Of these three surfaces the top was the clearest. From the color of the cube I interpreted that it was a light yellow block of wood which I was visualizing. The surfaces were smooth; all four edges of the top were visible but the edges of the front and side surfaces were less distinct. The object was of uniform color and brightness throughout except at the juncture of two planes where the edge was represented by a shadowy line of darkened wood color rather than by clear-cut, sharp corners. I noticed that no other form of imagery other than motor imagery of eye-movement tended to appear; I had no tactual or kinaesthetic imagery of handling the cube. (Under instructions to visualize an object which I have not inspected tactual-motor fashion recently, I find my attention almost wholly absorbed in visual and eye-motor experiences and with the shape, form, and color quality of the imagery.)"

13. *Observer B.* Same instructions. "I found myself tending to visualize a die. There appeared faint, fleeting and very schematic visual imagery of a small, cube-like form, three sides of which, including the top, were visible. The sides were light—the quality of a very light and dim grey, I think; the edges were darker. There was no visual setting; the object appeared in space before me but with nothing visualized around it, and on the faces of the cube there appeared faint, pencil-like dots which represented the spots on the die; these spots were mere points of brightness and stood out as specks a little darker than the adjacent surface. I could not count the spots for they were not clear enough nor were they definitely distributed, but together with this visual imagery I found myself saying in verbal imagery, 'one, six, two, five,' etc."

[Instructions: "I am going to read you a certain selection of prose. Attend to this reading as if you were going to be called upon later to recall what was read to you and attempt to translate the meaning of the passage as far as possible into visual imagery. After I have finished the reading begin at once to introspect particularly upon the visual imagery which was aroused while you listened. Do not make such an effort to visualize the meaning of the passage, however, as will distract from following its discourse.. Ready."]

The passage was from Parkman's "Oregon Trail," Standard English Classics edition, edited by W. E. Leonard and published by Ginn and Co., and is found on page 56, lines 5-23. The passage is as follows:

"A low, undulating line of sandhills bounded the horizon before us. That day we rode ten hours, and it was dusk before we entered the hollows and gorges of these gloomy little hills. At length we gained the summit and the long-expected valley of the Platte lay before us. We all drew rein and sat joyfully looking down upon the prospect. It was right welcome; strange, too, and striking to the imagination, and yet it had not one picturesque or beautiful feature; nor had it any features of grandeur other than its vast extent, its solitude and its wildness. For league after league a plain as level as a lake was outspread beneath us; here and there the Platte, divided into a dozen thread-like sluices, was traversing it, and an occasional clump of woods, rising in the midst like a shadowy island, relieved the monotony of the waste. No living creature was moving throughout the vast landscape, except the lizards that darted over the sand and through the rank grass and prickly pears at our feet."]

14. *Observer A.* "I was first aware of visual imagery of the sand hills, looming up one behind the other like a series of terraces, the hills in the distance rising up behind those in the foreground. All were colored a very faint washed-out yellow, like the sands of the western deserts, but possessed no detail; they were colored as if painted by a thin wash of water-color paint. The only variations in this color appeared along the ridges of hills and along the sides of higher ridges behind, thus marking off in my visual imagery in terms of a shadow the place where the summits of the nearer hills left off and the slopes of the hills farther back commenced, or loomed into view. This imagery lingered in consciousness but a brief moment and then the scene changed. I found myself standing on top of one of these foothills; portions of ground were visualized at my feet, in this same color, while off in front of me and extending as far as I could see, was a visualized plain. The plain was colored much as were the hills and here again, in the imagery, were no details—merely a broad expanse of surface—except where I visualized the Platte river winding hither and thither, becoming smaller as it extended farther and farther into the distance. Then for a brief moment I had visual imagery of nearer views of the Platte. First there appeared visual imagery of the river as one might see it from a train as one travels along near the bank. (This imagery, I think, is a vague memory image of a view I once obtained of this river when on my way west years ago.) In this image I saw about as much as one would ordinarily see from a point of view several feet away and slightly elevated above the level of the banks. The water was not colored but had a white or silvery glare as if brilliant sunlight were being reflected from its surface. The water seemed motionless at first; in fact, there was no motion in the imagery beyond a slight suggestion of currents of water which later appeared when I heard the word 'sluices.' At this juncture I had visual imagery of the Platte dividing into several sluices and at the nearest fork there appeared streaky-like shadows on the surface of the water which represented to me the dividing currents. The scene then changed again, I visualized hill after hill, passing me as if I were being silently carried through space at a terrific speed; after several hills had passed I then visualized a broad, flat, open area passing by; then would come a long, undulating ridge, colored as the foothills which I saw at first. This scene would give way to another broad, flat area of plain where nothing was visible except the yellowish-grey sand, smooth and unvaried by any detail. The next imagery of which I was aware consisted of visualized lizards darting across the sand at my feet, as if I were standing on the open plains. These lizards appeared as small, dark,

oblong forms, about four inches in length and in each my line of regard was centered upon the region of the hind legs which were represented in my imagery by short and slender extensions of the dark brown oblong forms. Between these slender extensions was a long slender streak, almost black, which represented a tail. Then I found myself visualizing tiny gusts of sand thrown up backwards and sidewise by the hind feet of the lizards as they scurried over the ground. I had several visual images of this sort, some of which were localized near me and others of which were projected off in the distance, on the ground, for several feet. These little gusts of sand would appear first on one side, then on another, as if I were running upon these little animals while travelling across the plains, although I was not aware of imagery of walking or of otherwise moving, myself. Once I fleetingly visualized a clump of trees off in the distance, in a desert setting, but here the imagery lacked detail. When I heard the words 'prickly pears' I at once had visual imagery of small, cactus-like plants, standing up about 18 inches high and growing up from the smooth, yellowish sand. This imagery included a greenish-grey stalk with spines protruding here and there of lighter color but of the same hue; I saw no branches, leaves or flowers. During the entire reading I had no tactual or kinaesthetic imagery beyond a slight awareness of eye-movement with the rapid shifts of visual attention from one object or position in my visual field to another. I saw no men, horses, or other objects.''

15. *Observer B.* [Same instructions.] ''As the selection was being read I was first aware of the stillness and the peace portrayed by the situation. This awareness consisted, I think, of an interpretation from total absence of tactual, motor or auditory imagery. Then I became aware, in terms of schematic visual-motor imagery, of the foothills near me. While I did not see the hills in this imagery, this awareness consisted of vague shadow-like lines with no visual setting, which shot hither and thither through space before me, and which were accompanied by marked tendencies for my line of regard to follow them. Here I was distinctly conscious of kinaesthetic imagery of eye-movement with incipient motions in my eyes. There also occurred incipient tendencies to follow these shifting lines with movements of my head. I then had a diffuse tactual image of coolness upon my face. Then I was aware of a peculiar complex which I interpret as a consciousness of romantic grandeur, depicted by the passage. This consisted of tendencies to breath more slowly and deeply, of a peculiar tenseness about the region of my diaphragm, together with tactual imagery of the warmth of the sun upon my face and back and faint pressure imagery of a breeze blowing against my face. These experiences gave way to a wealth of tactual and motor imagery of riding a horse across the plains and over the hills. I had very persistent and clear kinaesthetic imagery together with incipient bodily swaying movements of balancing myself in the saddle as the horse seemed to bound up a steep grade or now across a rough section on level ground. Then I would become momentarily absorbed in kinaesthetic imagery of rough jolts from a sudden change in the horse's stride or from an unusually long jump across, perhaps, a stream. There then appeared a wealth of tactual and kinaesthetic imagery of shifting my position in the saddle; auditory imagery of the crackling of dry grass beneath the horse's feet; incipient tensions in my legs as if I were pressing my feet against the stirrups; then I would have tactual and kinaesthetic imagery of suddenly pulling upon the reins, localized in my hands, arms and shoulders. Also I had tactual and motor imagery of the rhythmic bodily movements of trotting, of galloping, and of walking. Then I had tactual imagery of my shirt as if it were being blown tightly against my body by the wind; then came auditory imagery of the panting of the horse; auditory imagery of the splashing of its feet as we passed over boggy places; then, later, I had tactual imagery, localized at the bottoms of my feet, of stepping upon prickly pears, with cutaneous and gustatory imagery of handling and tasting the cactus. All of these experiences were intermingled with a wealth of affective

and organic states consisting of circulatory, respiratory and other muscular changes. These latter processes seemed to constitute an awareness of the expansive openness about me. In no instance, beyond the faint suggestion at first, did I have any sign of visual imagery."

The following introspection from observer *A* is here introduced in order to show the influence of tactual and motor processes in his imagery of objects recently handled.

[Instructions: Visualize the rifle which I showed you the early part of the morning. Then give me a detailed introspection on the imagery involved.]

16. *Observer A.* "As soon as the experimenter said 'rifle' I was aware of visual imagery of that section of the rifle which surrounds the hammer, the breech and the trigger, also back along the grip of the rifle as far as the peep-sight and ahead on the rifle as far as the opening from which the cartridge is extracted by an automatic device. This imagery was localized in the direction of my knees as if the visualized object were resting across them, with the barrel pointing to the left. Then my attention flitted momentarily to the under side of the rifle where I visualized the hole and spring-shutter through which one fills the chamber. This visual imagery was more stable although, I think, no clearer than visual imagery which I have described in previous sittings. I saw at one glance the two blocks at the lock in the breech, the hammer, part of the iron ring beneath the trigger and the trigger itself. Then there appeared, as this imagery persisted, tactual and motor imagery of placing my finger through the lever behind the trigger and my thumb upon the hammer; in this latter imagery the feature which stood out most prominently was the quality of strain involved in pressing the hammer back and down, with my thumb, as if in the act of cocking the rifle. This quality was localized both in my thumb and wrist. But no sooner was I aware of this motor imagery when I found my attention shifting from kinaesthetic qualities to visual associates which always accompany my kinaesthetic imagery. These latter consisted of black streaks and areas localized in my finger and thumb, also in my wrist, representing the muscular strain. Then this visual imagery changed to further visualizations of my finger and thumb in their positions as just described and here it was the musculature itself and not the synaesthetic process which was present in terms of visual processes. The portion of the barrel which I first saw was colored the quality of blue steel; the hammer was somewhat the same color but lighter while the tip of the peep-sight was almost white. I did not visualize the wood-stock and at no time did I have tactual imagery of the coldness of the metal or of pressure from gripping the rifle. (This visual imagery differs from my imagery of objects which I have not handled recently in that it is not broken up into disconnected sections or patches as is true of the former where kinaesthetic processes are lacking. This observation confirms many others which I have made in the past.)"

ii. Summary of introspective data on visual imagery.

Observer A. Under the instructions to visualize various situations or objects, observer *A* readily experienced combinations and successions of visual imagery to the exclusion of practically every other type of imagery with the exception of the kinaesthetic. This visual imagery was invariably rich in color or brightness qualities but lacked other details such as definiteness of outline and quantity of items visualized. As far as color and brightness were concerned his visual imagery seemed to possess such persistence and clearness as characterize similar imagery in a good visualizer. On the other hand *A's* visual imagery tended to be photographic; and where large objects were visualized, or where extensive scenes were imagined, hills, deserts, plains, rivers, rocks, trees and the like appeared ''washed'' with color. The shapes and outlines of objects were suggested by variations in quality or shade of color and brightness rather than by edges or lines.

Another prominent feature of *A's* visual imagery consisted of its patchy or disconnected character. Images, varied in number and in the objects which they represented, appeared in consciousness either in groups or in rapid successions but in either case this imagery tended to be discontinuous and to be separated by areas of a dark grey neutral background. For example *A* described visual imagery of rose-buds, ferns, a box, various parts of the human face or figure, various portions of a landscape, but each detail or each individual object tended to be separated from its neighbor by an indistinct and almost indescribable ''space'' or by an area of greyish visual setting. In the same fashion successions of visual imagery were broken up by short intervals in which *A* was conscious either of this grey visual setting or of other types of imagery such as tactual and kinaesthetic. One visual image or short succession of visual images would vanish before the succeeding group of visual images would appear, the reagent's attention meanwhile being occupied by other imagery, chiefly this visual setting. This state of affairs is not different, perhaps, from the behavior of visual imagery in a sighted person. For when one experiences successions of visual processes either sensory or imaginal he will undoubtedly discover that when one visual image fades away before the next image appears, his attention, in the interim, may be occupied by a ''blackness'' of indefinitely visualized space.

There are instances, however, when observer *A* is able to experience long trains of visual images in which one image merges without a break into its successor. Such instances, however, are rare except when synaesthetic phenomena are functioning, or when visual imagery constitutes a temporary schema or form, resembling, in character, a number form. Again, in case tactual or kinaesthetic processes accompany the visual imagery, the latter become less patchy and more persistent or stable. These facts are significant in connection with the functioning of synaesthetic phenomena for the reason that they demonstrate the striking difference between the behavior of visual imagery of objects or scenes as such and the behavior of that visual imagery which functions in *A's* synaesthetic processes. The latter are differentiated from the former, as we shall observe later, by greater persistence, stability, by a stereotyped character which is not found in "normal" visual imagery, and by their peculiar functioning in the development of meaning.

Synaesthetic phenomena appeared in connection with *A's* visual imagery of a person whom he had not met for several years, in connection with kinaesthetic imagery of handling a rifle and in connection with visual imagery of printed words or letters. It is of striking significance that the patchy visual imagery of professor *O's* ears, forehead, chin, and clothes (see introspection 6) was colored by the same yellow which is always aroused when professor *O's* voice is heard. In the winter of 1914 observer *A* heard his voice for the first time and it at once assumed this peculiar yellowish-buff color. Auditory imagery of his voice and visual imagery of him at once took on this same quality of yellow. In the winter of 1917 this color was described by observer *A* as a faded orange-yellow; during the winter of 1919 this color was described as a light brownish yellow and at the present writing this color is a "washed-out yellowish tan." Every form of imagery pertaining to professor *O* is affected by this synaesthesia and the imagery itself, if wholly visual, is colored by this yellow. Auditory imagery of professor *O's* footsteps are invariably yellow; if *A* is thinking of a book which *O* has written either the visual imagery of the book itself or the background on which the book is visualized takes on this same quality of yellow. Observer *A* has a century form which he constantly uses in connection with historical dates or epochs. A certain section of this century form, representing a period of time extending from the year 55 B. C. to the Saxon period in English history, turned yellow as a result of *A*'s having studied English history under this professor. Previous to taking this history course with professor *O* the section in *A's* century form, just referred to, was white. In like manner all memory imagery having to do with courses taken under professor *O* is affected by this same yellow. The following quotation from observer *A's* recall of certain facts concerning Gregory, a missionary to England, illustrates the point in question.

> 16. *Observer A.* "(If I were asked about Gregory, a certain missionary to England, and about his nationality and the time during which he visited England, my synaesthetic imagery would function as follows:) There first appears, in response to the verbal image of 'Gregory' a black splotch in the center of my field of vision; this blackness means 'Gregory,' while surrounding this black splotch there appears a band of yellow which means that I studied about Gregory in a course under professor *O.* The black informs me that the person represented is not only Gregory but that this person was either a Roman or an Italian. The yellow has come to mean, also, that Gregory is associated with England during the Saxon period. Thus, in order to place Gregory in the Saxon period of English history it is only necessary for me to call up my century form whereupon the black splotch which means 'Gregory' at once assumes a position in the form corresponding to a date falling somewhere in the middle of the eight century. On both sides of the black splotch there remains the yellow of professor *O.* (This is a fair test of the functioning of my 'professor-*O.*-yellow' for I have not studied or reviewed my English history for several months. What I can remember about Gregory is entirely represented in the behavior of the colors as described.)"

In the second instance—that of visual imagery of letters—we find a similar state of affairs. For example, the visual image of "t" appeared in the form of a printed "t" but its shape or form was indistinct. The distinct feature of the "t" was its reddish-brown color, and it was upon this color which observer *A's* attention was directed in the image. Similarly, the "h" lacked definiteness of shape or form but the important feature of the image consisted of its greyish brightness which very nearly blended with the visual setting upon which the "h" was projected. The shape and form of the "e" were also vaguely visualized but the light, dull white of the "e" stood out in focal attention. In 1917 *A* described the color of "t" as a dark chocolate brown; in 1919 this color was a dull brown; in 1921 it was a reddish-brown. Slight variations in the verbal descriptions of these colors may be traced to the use of different adjectives in successive introspections and the actual colors themselves may vary, slightly, when the letter occurs in various associative settings. The significant feature of *A's* visual imagery of letters, however, is the fact that in each letter this colored imagery is present, no matter what its setting happens to be, or no matter under what conditions the letters are visualized as long as the letters retain their individuality, *i. e.*, their individual meaning. Introspection number 10 quoted above is thoroughly typical as a demonstration of synaesthetic imagery in connection with letters.

In the third example of synaesthetic imagery which we found in *A's* introspections quoted above, it was kinaesthetic imagery which was associated with a degree of brightness and here the synaesthetic image was a deep black. A mass of introspective data definitely showed that the intensity of the black was proportional to the intensity attribute of the kinaesthetic image and that the size or area of the blackness was proportional to the amount of musculature involved in the kinaesthetic image. This peculiar black is typical of all of *A's* kinaesthetic processes whenever and wherever they occur.

Observer B. In contrast to the vast amount of visual imagery in observer *A, B* has very little imagery of this type. The few visual images which *B* was able to recall were exceedingly vague, fleeting and schematic. Imagery of color was limited largely to the greens with only a rare appearance of other hues. Brightness qualities far outnumbered color qualities. *B's* visual imagery, also, was exceedingly patchy and disconnected and was invariably supplemented or ''filled out'' by tactual and motor processes. Once a flashy visual image appeared it seemed to melt away or dissolve into a tactual and kinaesthetic setting. *B* found it impossible to control this fleeting imagery other than by resorting to cutaneous or motor cues and even under these conditions he could rarely succeed in reviving a visual image after it had once run its course. One striking feature of his visual imagery consisted of its shadow-like nature together with its lack of definite limits or boundaries. Another consisted of its appearance in space in the absence of a visual setting. It was projected in space but around the image was ''nothing''—the ''nothingness'' which a sighted person has great difficulty in understanding. It is the visual ''nothingness'' the significance of which one can imagine, perhaps, by contemplating upon what he cannot see ''back of his head.'' But *B's* visual imagery did not appear in an entirely negative setting for tactual or kinaesthetic imagery took the place of the extended visual field of a sighted subject and of our other blind reagent. A third prominent feature of *B's* visual imagery consisted of its confinement to visual-kinaesthetic schemata. Much of *B's* awareness of space consists of these visual-motor schemata in which extendedness or movement is simultaneously "seen" and "felt" in imaginal terms. But these spacial schemata very seldom include visualized objects.

iii. Visual imagery of A and B compared.

1. *A's* visual imagery is characterized by a wealth of color and varying degrees of brightness. *B's* imagery is confined very largely to brightness qualities alone.

2. *A's* visual imagery far exceeds *B's* in stability, persistence and complexity of behavior.

3. *A* possesses a remarkable control of visual imagery. *B* has almost no control of his visual images.

4. *A's* visual imagery appears in visual settings. *B's* appears in tactual and kinaesthetic settings.

5. Visual imagery is nearly always ushered into consciousness in *B's* case by vocal-motor, tactual or by kinaesthetic imagery. In *A's* case visual imagery itself may function as the stimulus or cue by which further visual imagery is aroused.

6. *A's* visual attention is confined to changes in hues, brightness, position of the image, or to shifts in size, shape and distance of projection and does not involve definite changes in clearly visualized outlines, edges, limits and similar differentia. *B's* visual attention is dependent upon the effectiveness of tactual and motor cues in producing changes in size, shape, hue or brightness.

7. The visual imagery of both reagents lacks minuteness or nicety of detai.l While *A's* visual imagery has remained rich in brightness and color qualities, owing perhaps to his entoptic phenomenon, hues and brightness qualities take the place of definitized outlines, limits or boundaries. In this respect *A's* visual imagery varies from that of a good visualizer. *A's* visual imagery differs from most sighted persons' and also from *B's* visual imagery in that it possesses a synaesthetic function. Definiteness of form and outline in *B's* visual imagery is provided for by tactual and kinaesthetic processes.

8. Both reagents agree that their visual imagery is more stable or persistent and that it possesses greater continuity when supplemented by tactual or kinaesthetic processes. Both reagents also agree that visual imagery of objects recently inspected or capable of being inspected tactual-motor fashion is far more stable

and clear than visual imagery of objects which cannot be so inspected. Whenever either reagent visualizes large objects or scenes those details stand out more clearly and persist longr which have been inspected through touch or movement. *B* is unable to ''see'' any object which he cannot or has not touched.

iv. The significance of A's synaesthetic imagery in processes of visualizing.

In order to understand the significance of the synaesthetic phenomena which occur in *A's* visual imagery let us resort to an analogy. Suppose one were to attend to the muscular contractions of clenching his fist. If one is a habitual visualizer he will visually localize these muscular contractions in the fingers and wrist. Again, if one's attention is suddenly attracted to a strain in the throat that strain will be localized visually. The kinaesthetic and visual elements may be simultaneously present to consciousness or at least very nearly so. In other words, part of the actual awareness of muscular strain will consist of a visual process. In other individuals who do not habitually visualize these motor processes it is conceivable that other factors such as verbal imagery or added motor phenomena such as head or eye-movement may be involved in the localization of muscular strain in the throat or wrist. The presence of these added processes whether or not they be visual facilitates the definite localization of the muscular strain in question. These supplementary processes function in the act of *perceiving* the strain. Without them it would be difficult to comprehend how the strain in question could be consciously localized at all. Again, let us examine the process of perceiving a distant locomotive whistle. One tends to turn his eyes or head slightly in the direction of the sound; perhaps he visualizes the distant source of the sound or characterizes the sound vocal-motor fashion. Also he may tend to analyze the muffled quality, or he may detect an echo, or he may note the greater definiteness of the sound as heard by one ear rather than the other, all of which supplementary processes contribute to his *perception* of the sound.

Returning to observer *A*, a mass of introspective material demonstrates beyond any possibility of doubt that *A* can no more ''image'' an arm-movement without seeing ''black,'' or visualize a ''t'' without seeing reddish-brown, or visualize professor *O* without that peculiar quality of light yellowish tan, than can an asynaesthetic individual become conscious of the direction from which a sound appears unless he tends to resort to such supplementary processes as visual, motor, verbal or other imagery. *A's* synaesthetic imagery functions exactly as these supplementary processes function—it is an integral part of the perceptual or conceptual process. So far as *A's* synaesthetic processes have thus been described they appear not as a new group or genus of mental activities but as a new species of an old and familiar genus—a species of *meaning*. For *A* the appearance of a light reddish-brown in response to the letter ''t'' means ''t''. The particular yellowish-tan aroused by a professor-*O*-stimulus means professor *O* and without this color observer *A* would be visualizing not professor *O* but an unrecognized or unidentified person. In a similar fashion, black, projected in the musculature while muscles are contracting, means ''muscular'' sensation and identifies that experience as a kinaesthetic one rather than as a tactual or an auditory experience. As a result, the original kinaesthetic quality of the experience tends to be ignored so far as the behavior of *A's* attention is concerned.

The significance of synaesthetic processes in *A's* case at least is far too great to be dismissed here with but one analogy. If an asynaesthetic individual were asked to visualize a person whom he had not seen for years he would find that his visual attention would be claimed first, perhaps, by a face in which certain features stood out more prominently than others. One of these features might be a peculiar color of skin, a mole, a mustache of certain shape, a certain degree of baldness, a characteristic wrinkle, or a combination of features. Together with this visual imagery there perhaps appears verbal imagery pertaining to past events in which this particular visualized person figured; or there is aroused an organic and motor complex which characterizes this visualized person as familiar. The possibilities are almost innumerable. But certain definite details are organized within the image complex itself or tend to crowd into consciousness together with this image complex and as a result the experience becomes that of a visual image of a definite, particular person rather than of some other person.

So, with our reagent. When he visualizes professor *O*, such details of additional visual, verbal or other imagery as have been described above are lacking but in their place there appears a particular quality of yellowish-tan. This color identifies the visual image as one of professor *O* exactly as the supplementary processes mentioned above identify a visual image in an asynaesthetic subject. *A's* attention is directed to a certain color quality rather than to a certain shaped chin, a certain profile, a peculiarly shaped mustache or what not. And furthermore, while *A* is visualizing this yellow-tan, it is a *familiar* yellow-tan in the same fashion as is a certain facial feature, in the visual imagery of the asynaesthetic observer, a *familiar* one.

A's so-called snyaesthetic images are but substitutes for a possible variety of secondary processes which occur under similar conditions in the asynaesthetic individual. They are substitutes, also, for the tactual and kinaesthetic secondary processes which occur in case of observer *B*. The functioning of synaesthetic processes is identical with the functioning of secondary processes in acts of perceiving or of identifying. Thus the functioning is the same in all cases although the mental ''content'' involved may radically differ.

Further evidence of the cognitive nature of synaesthesis may be found in *A's* introspections. In introspection 16 we found that *A* reported a kinaesthetic image which turned into a visual image of ''deep black'' localized in the thumb and wrist musculature. Under the proper conditions we found that *A* can be made to become aware of the ''blackness'' of muscular strain before he is aware of the kinaesthetic quality itself. In fact it is the *Aufgabe* which determines which of the two qualities—the black or the strain—shall be attended to first. If the strain claims attention first there is invariably a shift to the visual black. If the visual black is the first to claim attention in any given instance it may happen that the quality of strain fails entirely to develop; in fact it may be ignored entirely unless it happens to persist. Thus it happens that when the visual associate appears in the absence of its parent process (here the parent process is the kinaesthetic quality of strain) a black streak or area localized in the musculature *means* a localized strain quality. That is, in the presence of the appropriate mental set or preparedness, black may mean muscular strain in the absence of any intimation of the strain itself.

This and much other evidence shows conclusively, we believe, that when two imaginal processes appear together in consciousness, such as a visual black and a kinaesthetic strain, we have a clear case of synaesthesia but with the difference that the stimulus is not now a peripheral one as in case of the so-called synaesthesia proper. In case of synaesthesia the stimulus is a sensation. In the case of the black muscular imagery the stimulus is an image. The same is true of colored imagery of professor *O* or of different letters.

b. (Series 1 continued.) Auditory imagery.

i. Typical introspective data.

[Instructions: Call up auditory imagery of professor (X) saying at the close of a lecture: "The next natural division seems to be from thirty-one to fifty-one; take that for next time."]

17. *Observer A.* " I tried for some time to recall Prof. *DeB's* voice as he might repeat these words but was unsuccessful. I simply found myself experiencing auditory imagery of the experimenter's voice as he repeated the instructions together with the peculiar light, silvery grey patches which always accompany auditory imagery of the experimenter's voice and auditory perceptions of his voice, as well. In order to imagine how professor *DeB's* voice sounds I found it necessary to inhibit my own vocal-motor imagery. My own vocal-motor imagery, which tended to appear, produced series of visualized colors on which I could not prevent my attention from lingering. By keeping my own vocal-motor imagery inhibited (this I accomplished by tensing the muscles of my throat) I was able to recall a few very fleeting and sketchy auditory images of *DeB's* voice, such as the words, 'Pardon a personal reference,' which I often used to hear him say during his lectures. Each word was of very short duration and by the time the second appeared the first had vanished entirely; the timbre was, as such, indistinguishable form the dark, reddish brown color which always identifies his voice. The imagery seemed to be 'pinched'; he was speaking as if he were hurried or slightly embarrassed; on attending closely to the visual qualities of his voice I was able to obtain more definite auditory imagery; the enunciation became more distinct; the quality was less muffled; and his speech seemed to take on the quality of his lecture voice as I have heard him from a distance of 30 or 40 feet. I was then aware of visual imagery of his teeth but I saw nothing of his facial features, of his clothes or of his general appearance. During all of this time I was dimly aware of the persisting strains in my throat from inhibiting my own verbal imagery. The dark reddish brown synaesthetic imagery persisted throughout and it was by means of this latter imagery that I was able to describe the auditory qualities of his voice. Both auditory and visual qualities were present to consciousness but the visual qualities were invariably the claimants of my attention. When I attempted to analyse the auditory qualities as such I found that I was always resorting to features of my visual imagery."

18. *Observer B.*. Same instructions. " I could readily obtain distinct and persisting auditory imagery of the statement just quoted in terms of Mr.*M's* voice. The quality was good; each feature of the imagery was clear and rich in detail. I detected the liquid suavity which is strikingly characteristic of Mr. *M's* voice; I noticed characteristic pauses between each of his words

and even heard him utter his peculiar 'ah' sound between the phrase 'fifty-one' and the word 'take'. Articulation in my auditory imagery was characterized by marked definiteness; the pitch stood out with equal clearness. While this imagery was presenting itself I tended to imitate his voice in vocal-motor fashion, emphasizing the words as I imagined Mr. *M* emphasizing them. So clear was the imagery and so qualitatively perfect that I at once found myself saying in vocal-motor imagery: 'that is certainly Mr. *M.* all right'."

[Instructions: Recall some familiar tune. Can you hear yourself singing it? Can you hear it played upon the piano? Can you hear it played on the violin? Can you hear a chorus singing it?]

19. *Observer A.* " For a considerable length of time I tried to select a tune which I could hear in terms of auditory imagery but was entirely unsuccessful. Finally I thought of 'Yankee Doodle' and centered my attention upon it. The quality of my auditory imagery was very poor and indistinct and was confused with vocal-motor tendencies which latter were exceedingly strong. What little quality of tone was present seemed to be hoarse and muffled with only a faint suggestion now and then of the timbre of my voice. I was able to recall imagery of only the first few measures of the tune. Then the auditory imagery vanished and I found myself attending to a strained condition in my throat as if I were still trying to innervate the notes. Together with this auditory imagery of my own voice I was distinctly conscious of the color qualities which always accompany my own voice when I actually speak as well as when I have auditory imagery of my voice; I was also aware of spots of visual 'brightness' which represented the notes I was endeavoring to sing. I noticed, further, that my auditory imagery was slow, labored and 'dragged out' and that the colors brightened with rises in pitch and darkened with lowerings in pitch; in fact differences between one note and another were marked off much more by vocal-motor imagery and by changes in these colors than by variations in the auditory qualities themselves. The colors lingered after the auditory imagery itself disappeared but along with these persisting colors I was aware of persisting vocal-motor efforts of preparing to make musical sounds. The color of the imagery was a thick, smoky blue which appeared in small, cloud-like forms. When my imagery changed pitch these cloud-like forms not only brightened or darkened but tended to roll upward for higher pitches and downward for the lower notes. So closely was the visual imagery associated with the auditory that I could hardly tell the one from the other. When I thought that I was describing actual sound qualities I discovered that I was describing qualities or behavior of the visual accompaniment. Yet I was able to tell when the auditory processes themselves dropped out because of a dulling and shrinking of the visual processes themselves. After considerable effort I found it utterly impossible to imagine Yankee Doodle played on the piano or violin. It was equally impossible for me to hear voices singing this tune."

20. *Observer B.* Same instructions. "(I recalled the tune of 'A Heart Bowed Down.') I could hear myself singing this tune with a rather satisfactory degree of clearness but noted that, throughout, vocal-motor tendencies were very strong. While my auditory processes were clear and presistent, they were characterized by a 'deadness' or lack of richness of quality; the timbre was shallow and lacked resonance. I could not imagine the tune played on a piano but had definite auditory imagery of a violin playing the melody. Here the imagery was clear, intense, persistent and of good quality. I distinctly heard the stringy or twangy quality of the tones; also the rich, smooth, mellowness of a good instrument. Nevertheless the quality seemed to lack 'point', which, I believe, must be inability to detect the finer features of a violin tone in terms of imagery, alone. (I persume that I am comparing the quality of my auditory imagery with the quality of auditory perceptions of violin tones when I characterize the quality of my auditory imagery as lacking in 'point'.) Along with this latter auditory imagery I had very clear and definitely localized

kinaesthetic imagery of playing a violin, together with a very fleeting and schematic visual, shadow-like image of the movements of an unseen bow across a vaguely localized spot where the strings might have been. The shadow appeared in space but had no visual setting whatever. Its setting was the motor imagery which I have just described."

[Instructions: Recall auditory imagery of a chorus singing an oratorio or of an orchestra playing.]

21. *Observer A.* " I was unable to recall auditory imagery of a chorus but succeeded in obtaining sketchy auditory imagery of an orchestra playing the Overture from Poet and Peasant..... The first auditory imagery was that of a flute playing a succession of very rapid notes somewhat toward the latter half of the selection but at just what place I am unable to tell. I heard only a few of the very highest notes. For not more than three or four notes in succession there appeared the characteristic mellow, wood-like quality, intimately fused with tiny, blue, cloud-like forms, which latter rapidly piled upward and upon one another as the flute tones shifted upward in pitch. All of this imagery was exceedingly flashy and fleeting and gave way to similarly fleeting auditory-visual imagery of violin tones. The violins were apparently playing the same notes as did the flutes, for the behavior of the visual forms was similar. I knew that my auditory imagery had changed from flutes to violins for the reason that my visual imagery changed from the tiny blue clouds of smoke which meant flute tones to mahogany-brown cloud-like forms for the violins. These colors also varied in brightness as the tones varied in pitch. Next I was aware of sketchy auditory imagery of horns playing at a much lower pitch and I saw the characteristic yellowish-grey splotches which mean horn tones. I found it impossible to begin at the beginning of the selection and to hear any considerable part of it played. In the absence of any auditory imagery at all, however, I can obtain long and persisting successions of visual images—varying colors and brightnesses—which mean different portions of the selection. The quality of this imagery represents different qualities of tones, *i. e.,* different musical instruments; the behavior of this imagery represents rapid runs, chords, varying pitches and the like. It is all so fast and complex that I cannot fix my attention upon any one group of images long enough to describe them in adequate detail. (This imagery, however, is definitely distinguishable from the colors and brightness of my visual, sensory field.)"

[In order to ascertain whether this visual imagery was at all faithful in representing different portions of the overture, the experimenter subsequently played the overture to observer *A* on the piano. Since *A's* imagery stood for orchestral rather than for piano tones, the piano tones changed the quality of *A's* memory images of the selection. Nevertheless *A* was able to recognize the outstanding features of the overture in terms of recurrences in this characteristic behavior of his visual synaesthetic processes. The piano rendition stimulated shiftings in visual imagery, and peculiar successions or flights of visual forms just as had an orchestral rendition done in the past. *A* repeatedly detected similarities between the behavior of his visual forms during the piano rendition and the behavior of these forms (although differently colored) in the auditory recall of the orchestral rendition. Moreover, the detached visual imagery, described in introspection 21, was recognized so far as its behavior was concerned during the hearing of the selection on the piano. There is no doubt, therefore, that synaesthetic imagery, detached from its parent processes, may be as faithful to the original selection as is the auditory imagery itself, in an asynaesthetic subject. Added evidence fo this fact may be found in the circumstance that observer *A* recognized in terms of behavior of synaesthetic imagery certain sections of the overture which he was unable to revive during the voluntary recall.]

22. *Observer B.* Same instructions. " I recalled auditory imagery of a chorus singing Mozart's 'Twelfth Mass'. There first apeared very clear and beautifully toned imagery of the opening bars. The voices were well blended,

the tenors, however, dominating. Along with this auditory imagery I found myself tending to join in the singing in terms of auditory-vocal-motor imagery of my own voice. The quality of pitch stood out clearly in the auditory imagery of the voices; each voice seemed to be directly on the pitch and the tones were well rounded, full and resonant. After the first few bars all voices dropped out except the tenors whom I heard singing for several additional measures. Then I was aware of intensive muscular contractions about the chest as if I were beginning to take a very deep breath; I had a peculiar tenseness in the region of my diaphragm, a widely diffused feeling of exhilaration which consisted of tendencies to sit more erectly in my chair and to sway my head and the upper part of my body to the rhythm of the music. There was also a contracted condition of the shoulders, arms, back and throat as my whole bodily attitude became tense. Thereupon there burst into consciousness loud and penetrating auditory imagery of the entire chorus singing 'Glorious'; at this juncture I was dimly aware of inhibited breathing; of marked pleasantness, coincident with tendencies to smile. (These latter experiences I interpreted as a consciousness of the grandeur of the music.)"

[Instructions: Recall auditory imagery of a locomotive whistle.]

23. *Observer A.* " I can obtain no auditory imagery of the whistle. Instead there appeared very vivid visual imagery, first, of a floating cloud of beeswax-yellow which represented a certain freight whistle I have often heard. There then appeared a blue and grey mixture which stood for a passenger whistle. Each was labeled in terms of auditory-vocal-motor imagery. In neither instance, however, could I obtain any auditory qualities whatever."

24. *Observer B.* Same instructions. "I at once had a very clear and intense auditory image of a locomotive whistle; the sound was loud and shrill but persisted for only a short time, together with the quality, which was harsh and piercing. I was conscious of a distinct feeling of unpleasantness. This latter consisted of tenseness about the chest muscles, of tendencies to frown and of an expansion somewhere in the region of the abdomen which I think were concerned with tendencies to breathe more rapidly. I also noticed a tightening about the jaws. All of this was accompanied by a clear but sketchy auditory-vocal-motor: 'Gee, that's loud!' (I reacted to the auditory imagery just as I would have reacted to an actual whistle but with a lesser degree of intensity.)"

ii. Summary of introspective data on auditory imagery.

Observer A. Notwithstanding the fact that observer *A* is blind and that we might therefore expect his auditory imagery to have been developed by means of constant use in every day life we find on the contrary that this type of imagery is exceedingly fleeting, vague, sketchy and meager as regards detail. *A* is unable to recall in auditory terms many sounds and noises which are perfectly familiar when perceived. Because of its vagueness of timbre and pitch, its brief duration in consciousness and dearth of detail, auditory imagery is subject to only slight voluntary control. This control is secured very largely by means of detached visual synaesthetic images which suggest their parent auditory qualities and at times by means of vocal-motor processes. Very rarely will one auditory complex, itself, suggest another.

The *Aufgabe* to recall auditory imagery and subsequently to describe it resulted, in this experiment, in an attempt to isolate the qualities and pitches of the imagined sounds from their visual accompaniments but inevitably the visual process which accompanies every auditory image claimed the focus of *A's* attention. It turned out that efforts to attend to the auditory qualities themselves resulted in a diminishing of the clearness of the visual accompaniments, and in such instances *A's* attention shifted to the muscular elements of attending rather than to the auditory qualities *per se.* Thus it seems that in attending to sounds as such (and the same is true of attempts to attend to any sensory process other than the visual) one of two things inevitably results: either the effort is shunted into motor channels or the effort results in a shift to the visual accompaniment. If the effort results in a dominance of muscular features the visual features of the experience at once tend to fade. Consequently at times in *A's* introspections there appears not only a meager description of the auditory qualities but also of the visual. We believe that the reason for this is to be found in the fact that observer *A* can describe auditory qualities only in terms of visual qualities and hence, when the latter are non-focal, it is impossible to identify the auditory qualities themselves. In this fashion efforts to isolate the auditory qualities as such render it difficult to observe the accompanying visual imagery. The effort thus defeats itself.

The colors which are associated with auditory imagery are invariably identical with those colors which accompany corresponding auditory perceptions. The former colors, however, may be less vivid, more fleeting, less saturated or less bright than the colors which accompany the analogous perceptual processes. Obviously this state of affairs is due to the fact that auditory images are less stable and are ordinarily, in themselves, less clear and definite as regards qualitative detail than are the corresponding perceptual experiences. On the other hand his introspections on auditory imagery have shown that the visual accompaniments may become detached from their parent processes, the auditory images, and may appear alone in prolonged trains or successions. In this fashion there may appear in *A's* consciousness successions of colors or degrees of brightness which stand for remembrances of successions or of combinations of tones. This state of affairs is most likely to occur as a result of an *Aufgabe* to recall auditory imagery which has apparently decayed beyond the possibility of easy arousal, and shows that the visual associates of auditory images appear more readily than do the auditory images themselves. *A* frequently experiences this situation in every day life, particularly in trying to recall names of persons. The color which symbolizes a certain name may appear detached from its parent process and no amount of effort will result in recalling the name itself.

Observer B. Auditory imagery plays a very important rôle in all of *B's* higher mental processes, although, as we shall discover later, it is less important than cutaneous or kinaesthetic imagery. Prominent features of his auditory imagery consist of its clearness, intensity, wealth of qualitative detail, wideness of range and variety, readiness of voluntary control, but of relative lack of persistence and lack of exact faithfulness to the delicate qualitative features of his auditory perceptions. As in the case of his visual imagery *B* finds himself tending to translate auditory imagery into kinaesthetic processes. If it is his own voice or another person's voice, a tune or melody played upon a musical instrument which is the subject matter of this auditory imagery, kinaesthetic processes invariably constitute a setting or background, and here this setting is usually vocal-motor or manual-motor imagery. For example, while *B* was experiencing auditory imagery of a violin he was aware of manual-motor imagery of playing the instrument.

iii. Auditory imagery of A and B compared.

1. *B's* auditory imagery far exceeds *A's* in all matters of attribute and behavior.

2. In contrast to *B's* kinaesthetic background, *A's* settings for auditory imagery are largely visual with now and then a vocal-motor accompaniment.

3. Both observers agreed that auditory imagery was more stable when accompanied by other forms of imagery. Moreover, the presence of a background or setting was definitely correlated, in both observers, with wealth of quality and variety of range in the auditory imagery.

4. Both reagents resorted to other types of imagery other than the auditory in a voluntary attempt to control the auditory

images themselves. Both reagents had recourse to vocal-motor imagery but in *A's* case this method proved to be a disadvantage for the reason that it resulted in arousing extra visual imagery which dominated consciousness to the exclusion of the desired auditory-visual imagery.

5. *A* is synaesthetic with respect to auditory imagery. *B* is not.

iv. Significance of A's synaesthetic processes in the field of auditory imagery.

The following considerations point to the similarity of synaesthetic phenomena and synaesthesia proper in the field of audition. In both instances the behavior and properties of the associated visual image depend upon the behavior and properties of the parent process as long as the latter is present in consciousness; in both instances the associated image appears to have the same function or value—that of identifying the parent process. (This observation we have made only in a general way so far. It remains to be determined whether this fact is invariably true.) On the other hand we have found a singular difference between synaesthetic phenomena and synaesthesia proper. In the latter the associated image seldom appears in the absence of the primary process while in the former the associated image may frequently appear without the primary image to which it is normally attached. Whenever the associated image thus appears detached and alone it symbolizes or stands for the primary image which is lacking.

It is evident that in the synaesthetic phenomena of *A's* field of audition the implied qualities and behavior of auditory images are described and identified in terms of their accompanying visual images, and that when *A* wishes to attend to auditory qualities as such he can do so only by way of a visual "route." This, in our estimation, can signify only one thing, namely, that the act of becoming conscious of auditory qualities in *A's* case demands a visual image. This means that in order to "cognize" an auditory image —for that is what is implied by becoming conscious *of* an auditory image as such—a certain behavior of attention is necessary or a certain and very greatly attenuated process of recognizing is implied. In the process of recalling definite and particular auditory images the asynaesthetic subject evidently uses "old" auditory imagery itself or else secondary factors, such as are involved in the act of perceiving a sound. Our synaesthetic subject employs visual imagery instead. But this is not an extraneous or unnecessary habit which observer *A* has developed. It so happens that *A* cannot become conscious *of* an auditory image in the absence of its identifyer, the visual image, any more than can an asynaesthetic person become aware of a flute tone, for example, either without a definite standing-out of a characteristic woody or punky, hollow-like quality or without some secondary criterion such as visual imagery of a flute, someone playing a flute, or such as the verbal image, "flute." *A's* visual synaesthetic images are *criteria* of his auditory images. They are not vicarious processes. *A* is able to visualize a flute; he can say the word "flute." He has auditory imagery of flutes. The problem is simply this: an asynaesthetic person must have *other processes* aside from a bare, raw, or isolated and indescribable quality of tone before that tone, even in terms of imagery, can become a *flute* tone. *A's* mental life offers no exception to this general rule. *A's* synaesthetic images, so-called, constitute these *other processes*. In other words his visual associates of auditory images lend *meaning to the auditory imagery itself.*

c. *Tactual imagery. (Series 1 continued.)*

i. *Typical introspective data.*

[Instructions: Recall tactual imagery of roses lying in a box and backed by ferns.]

25. *Observer A.* "As the experimenter said 'roses' I was aware of momentary tactual imagery of the feel of the buds, localized at the tips of my fingers and in the palm of my right hand; no sooner had this imagery appeared, however, when my attention shifted very suddenly to a group of tiny blocks of faint light. This latter imagery was not visual imagery of the rose buds themselves but consisted of visual synaesthetic processes which always accompany this quality of pressure. I then revived this tactual imagery, the exact details of which I had not observed previously, and detected the spongy-like softness of the sides of the buds, and this imagery, like the first, was not only localized at my finger tips and palm but was accompanied by and tended to shift into visual imagery. In every instance the visual synaesthetic processes persisted longer than did the tactual qualities. Then, as the experimenter said 'ferns' I had fleeting tactual imagery of ferns pressing against the ends of my fingers, together with imagery of coldness; the coldness quality dominated and at once the entire experience developed into a visualized, synaesthetic cold. As before my attention shifted in the direction of visual from the tactual processes. I was then aware of the closer edge of a box, in terms, first of tactual imagery localized on the under side of my wrist as if the box were pressing against my wrist while my hand might have been extended over into the box itself. Again this imagery at once turned to visual imagery. Then there returned tactual imagery of ferns localized on the inside of my thumb and index finger as if I were holding a fern in my hand, but at this juncture the tactual imagery, the qualities of which at no time stood out focally in consciousness, as such, suddenly gave way to visual imagery of tiny bars of light; these resembled in brightness and in behavior the sparkles from a large diamond and meant to me the roughness of the tactual imagery. I forgot to mention

that the color which appeared in connection with the image of coldness was the usual bright silvery light which always means coldness. It was coldness which dominated in the first tactual imagery of the ferns; now it was the roughness of the ferns. All during this time I was dimly conscious of persisting colored forms, characteristic of the experimenter's voice; these colors were suspended in space in the left margin of my visual field—the region nearest the experimenter. I should have mentioned also that the dim white light associated with the pressure of the rosebuds was localized at my fingertips and palm, as was the tactual imagery itself; the tiny bars of light which appeared in connection with the roughness of the ferns and the white silvery area which appeared in connection with the coldness of the ferns were likewise localized on my right hand. The size of the visual image corresponded to the area of the tactual image in each case. The tactual imagery appeared suddenly throughout, as if momentarily suggested by the experimenter's words; but it disappeared equally as suddenly. At no time was I conscious of kinaesthetic imagery of handling the buds or of such imagery as picking up the box or its contents. Neither did I have tactual imagery of the tips of the buds or of the prick or sharp pressure of the thorns. This imagery I can recall, now, but I was not aware of it immediately following your instructions."

[Further instructions: You mentioned seeing the colors which stood for the experimenter's voice. Can you describe the behavior of your attention with respect to these colors?]

26. *Observer A.* "During the experiment just performed I at no time attended strictly to the qualities of the experimenter's voice as he read the instructions. My attention was centered upon the meaning of the words as it seemed to issue from the resulting imagery which at once appeared and which I have just described in the preceding introspection. Rather than being aware, nonfocally, of the sounds of the experimenter's voice, I was nonfocally conscious of the accompanying colors. The colors and not the sounds were in the 'background' of my consciousness while I was experiencing the tactual-visual imagery. (Perhaps I can make this clear by an analogy. Suppose you were looking down into a valley, but with your attention focussed upon a house in the foreground. You would then be aware only non-focally of the hills in the background. In similar fashion visual imagery of the experimenter's voice was present but was in the margin of attention as well as in the margin of my visual field and it was not attended to, focally, at any time during the experiment. It lacked definiteness and I noticed no details in the imagery; I was aware only of its general features and of its presence. The fact which I noted about the experience consisted of the relative position of the imagery in my visual field and that this position was in a direction toward the experimenter himself."

[Further instructions: Can you describe the behavior of your attention with respect to the presence together in consciousness of your tactual and visual imagery of the rose buds and ferns?]

27. *Observer A.* " One instant I was aware of tactual qualities but in this awareness there stands out no definite or detailed item or characteristic of that quality. It is merely inferred tactual quality. The tactual imagery persists in this vague, undifferentiated fashion only long enough for my attention to shift to visual qualities. Thus the shift of attention, in this case, was almost instantaneous, but not quite; (I am doing this now, as I introspect) I am able to concentrate attention upon an effort to prolong this tactual imagery in which case I find that my method has consisted of resorting to kinaesthetic processes of handling the buds and ferns. But no sooner does this kinaesthetic imagery appear when my attention is claimed by the visual associates of the kinaesthetic imagery. (Suppose, for example, that I am making the movement of inspecting the heel of my shoe. I first obtain kinaesthetic imagery of reaching down toward my foot but the kinaesthetic quality at once gives way, during a rapid shift of attention, to the blackish streaks which accompany the motor imagery.

And if I attempt to single out the kinaesthetic quality as such or the tactual qualities as such, the visual associates become indistinct and tend to disappear altogether. I am able, I have often observed, to attend to both the primary and the secondary processes at the same time but only for the smallest fraction of a second and with the result that both processes tend to lose their identity. Unless I am prepared, by the proper *Aufgabe*, to attend to both, my attention always shifts *at once* toward the visual process the instant the primary process appears. Chronologicaly, then, the primary process, under the proper *Aufgabe*, does appear first, but so long as it persists it is vague, undifferentiated and absolutely impossible to describe other than by the term 'something.' "*

28. *Observer B.* Instructions as for introspection 25. " I was able at once to feel the softness of the petals, their smoothness, their fineness of texture, all of which features were localized, in tactual terms, at my finger tips. The imagery was exceedingly clear and real; at times I almost thought that I was getting real sensations; I was surprised at the vividness and persistence of this imagery and at its minuteness of detail; and this awareness, together with kinaesthetic imagery of moving my fingers about over the buds, made it almost impossible for me to keep my fingers still. Shifting from one detail to another with no loss in vividness and with continued nicety of quality my attention went from the edges of the petals as they curl over, to the pairs of petals as one extended slightly beyond the other but remained very close to it, then to the masses of petals in the center of the bud. There then followed equally as vivid and detailed tactual imagery of the ferns, of the edges of the rose leaves, of the flat surfaces of the leaves, and of the edges and smooth sides of the box. This latter imagery is of strikingly different quality, however, from my other tactual imagery. While I had, in tactual terms, the sharpness of the edge of the box and the glassiness or fine smoothness of the sides of the box, there is definitely present in this latter imagery a hardness which does not characterize my imagery of the buds and ferns. This quality of hardness does not seem to be entirely tactual, although I was not at the time distinctly aware of any other definite sensory qualities. I believe, however, that with this tactual imagery of the box there appeared, disguised as hardness, some kinaesthetic factors of resistance. The tactual imagery of the roses possessed the softness of silk; the smoothness of the ferns resembled the velvety smoothness of thick, heavy velour; the smoothness of the box suggested a glassy, almost slippery surface and was characterized by the firmness or resistance of a hard object. There was no setting in connection with this tactual imagery other than the kinaesthetic imagery which I mentioned. But this latter was mingled throughout with the tactual."

[Instructions: Obtain tactual imagery of the word "dog" written in American Braille.]

29. *Observer A.* "(I can readily construct this tactual imagery but not without recourse, first, to my visual kinaesthetic imagery of the letters 'd', 'o', and 'g.' I have not used American Braille for two years.)

Following my awareness of the instructions I found myself visualizing the letters of the word 'dog' in their appropriate colors. There first appeared visual imagery of the 'd,' then of the 'g,' followed by the 'o;' this imagery consisted of small areas of color localized off in space a short distance from me—a bluish-grey-green for the 'd,' a dusty-grey-green for the 'g,' and a dark, smudgy grey for the 'o.' (I believe that my attention shifted from the 'd' to the 'g,' skipping the 'o' for the reason that the two colors are very similar.) After this imagery had once appeared it shifted its position to a region nearer

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*In certain introspections there exists an apparent confusion in terminology when observer *A* speaks of tactual, kinaesthetic, or auditory imagery as if it were, as such, present to his consciousness. It has been necessary to retain this terminology for clearness in meaning, but it should be understood that, throughout, the reagent refers to an undifferentiated and indescribable process as far as tactual or auditory qualities themselves are concerned. A consciousness of auditory or tactual imagery is an interpretation dependent upon the functioning of the accompanying visual process.

me as I began to have faint kinaesthetic imagery of moving my finger upward along the surface of a piece of tag-board and over what might have been some imagined points. At this juncture the visual imagery began to shape itself into the general forms or figures which would be made by the arrangement of the points of the Braille letters 'd,' 'o,' and 'g.' Even up to this time I was unable to obtain tactual imagery of the Braille letters; the imagery so far constituted my efforts in this direction. I then had kinaesthetic imagery of moving my finger along an imagined (visual) tag-board toward these visualized forms which were now projected upon the yellow, visualized paper. I then momentarily became aware of tactual imagery of the 'd.' This awareness did not consist of individual pressures from the points which constitute a Braille 'd' but of a generalized awareness of their triangular spacial arrangement. Even this awarenes of a triangular shaped form is an interpretation largely from the fact that in this tactual image my attention is centered not upon the three sides of a triangle but upon the position in the spacial figures where a point is missing, which point, were it present, would form a square with the other three points. This tactual image was localized at the tip of my right fore-finger and was regular 'Braille' size; and for a moment, I believe, I was conscious of the more or less punctiform but yet blunt character of the imagery, although at no time were the individual points recognized as such. At the moment my attention was centered upon the missing point the tactual image, itself, involved spacial extent but this spacial feature was not present to consciousness as such but was interpreted in terms of a sudden and subsequent shift of attention to a visualization of this space in the form of a triangle. Through all of this the colored visual imagery which had previously meant to me that I was trying to obtain tactual imagery of the 'd' persisted and at this juncture of my procedure it was this visualized 'd' which assumed the triangular shape. My tactual images of the 'o' and of the 'g' were less distinct for here the visual features of the experience claimed attention throughout; there were no shifts to tactual qualities as occurred in connection with the 'd'. In each case I had visual imagery of these letters localized as was the visual imagery of the 'd'; the 'g' was fairly definite with respect to color and localization; the points of the 'g' stood out as pane-like sections of light grey-green. What would correspond to the sash of this window-like figure consisted of tiny bands of neutral grey; the whole visual image was projected upon a neutral grey background. (By this time the yellow tag-board had disappeared.) My attention was then claimed by the visual imagery of the 'o' which now definitized into a short oblique line, colored, and slanting in the direction of the points which form the Braille 'o.' The upper portion of this oblique line, which corresponded to the upper point of the Braille letter, tended to take on the yellow of the tag-board, which now tended to become visualized; the lower section of this oblique line was dark, smudgy and almost black—my synaesthesia for 'o'. Then I found my visual attention wandering from these letters to the visual background of neutral grey. All of the imagery which I have just described was very fleeting and appeared with lightning-like rapidity, although, throughout the entire experience, the qualities or hues of the letters persisted. As my attention shifted during the latter part of the experience to the visual background, the individual colors which stood for the letters disappeared and there was left only a vaguely visualized section of a piece of tag-board. The area thus occupied by the letters now contained only the yellowish-grey of the paper upon which I had been projecting the letters themselves."

30. *Observer B.* Same instructions. "As soon as I perceived the instructions I at once had a mass of tactual and kinaesthetic imagery of the letters, of arm and finger movement and of the paper on which the points were punched. There first appeared tactual imagery of smooth tag-board together with kinaesthetic imagery of moving my finger from left to right along the surface of this paper as if I were about to approach a Braille letter. I was then conscious of very vivid and intense tactual imagery, blunt and yet limited

almost to a point, of the first dot of the letter 'd'; this image was localized rather at the side of my finger than at the very tip just as the actual sensation would have been perceived had I come upon the point with actual finger movement. This was immediately followed by equally as vivid and definitely localized tactual imagery of the remaining points of the 'd'. For a brief instant, in this latter imagery, the individual points did not stand out, but they soon became definitized and arranged in the characteristic grouping of the 'd.' In the tactual image itself I found that my attention, however, was not focussed upon the pressure qualities nor upon the triangular shape of the spacial arrangement of points but upon that region in the figure where a fourth dot would be if the figure were a square. [Notice that Observer *A* reported the same experience in introspection 29.] There then occurred kinaesthetic imagery of moving my finger to the right in the direction of what would have been the next letter of the word 'dog' had I been obtaining the word in perceptual fashion. This was closely followed by tactual imagery first of the right hand point of the 'o' and secondly of both points; at this juncture the two points appeared in their proper spacial relations, forming an oblique line extending downward from left to right. Tactual imagery of the 'g' followed immediately in similar fashion except that the behavior of my attention differed slightly. The imagery itself was as clear and as definitely localized as was the former imagery, but as I had kinaesthetic imagery of moving toward the right I obtained tactual imagery of not one point alone, as before, but of two points, and these points appeared spacially grouped as they were being imagined. Here I was not aware of the pressure qualities as such but of the spacial grouping as such. That is, I imagined them as a bar, not as two points. Following immediately upon this and so rapidly that the two experiences were almost simultaneous, the bar thus imaged developed into a tactual square. Here, again, it was the spacial arrangement of the points and not the distinct and separated points themselves which stood out in focal attention. Yet the entire imagery possessed as much clearness and definiteness of localization at the end of my finger as did the previous imagery in which the points stood out for a time as separate bluntnesses. All of this happened very quickly and had no sooner taken place than I found myself tending toward incipient movements, localized in the arms and shoulders, of making large, sweeping motions as if I were about to draw enlarged letters of solid lines instead of making these letters of points. I noticed that my tactual imagery developed very suddenly to a high degree of focality and that it shifted exceedingly rapidly from one detail to another with no perceptible break in between. As one detail in the tactual imagery gained clearness the shift was so rapid to the next detail that I noticed no perceptible diminishing in clearness of the preceding detail before I was focally conscious of the succeeding detail. Each letter was accompanied by incipient vocal-motor tendencies to pronounce it."

ii. Summary of introspective data on tactual imagery.

Observer A. A study of *A's* descriptions of his tactual imagery would lead one to conclude that his ability to image the "feel" of objects is as limited as we found his ability to image sounds. Tactual qualities themselves are vague and undifferentiated as was his auditory imagery. Tactual imagery is fleeting, disconnected, rather lacking in detail and unstable. Every detail has its visual counterpart in synaesthetic imagery and every tactual image at once gives way to this visual accompaniment. The same shift of attention from tactual to visual qualities appears in his tactual imagery as took place from auditory to visual qualities in his auditory imagery. Thus, like his auditory imagery, his tactual processes are broken into disconnected series by repeated shifts to the visual accompaniments even when tactual imagery itself appears in relatively prolonged series.

As was the case in auditory imagery, *A's* attention does not shift from one tactual quality directly to another tactual quality but from a tactual to a visual image and then back to a tactual image again. Only by voluntary effort which involves kinaesthetic imagery and incipient muscular movement is *A* able to inhibit this tendency to shift from a tactual to a visual quality whenever a tactual image appears in consciousness. But under these circumstances, attention never lingers focally upon tactual qualities as such but at once shifts to the kinaesthesis of attention and hence over into visual processes again. In other words we find a duplication of the situation which obtained for auditory imagery, namely, that a tactual image as such is never the object of focalized attention.

As with his auditory imagery, visual associates persist longer in consciousness than do the combined tactual and visual processes. It is not uncommon that a tactual image itself is ushered into consciousness by means of its visual associate. The *Aufgabe* to recall tactual imagery results at first in the arousal of combined tactual and visual complexes but if the process of fulfilling the instructions be prolonged all tactual qualities tend to disappear with the result that the detached visual symbols represent the tactual qualities in the absence of the latter. We found the same to be true in his auditory imagery.

If a tactual complex such as a combination of pressure and cold was being experienced in terms of imagery the dominating feature in the complex determined the resulting color or brightness. Thus when observer *A* had tactual imagery of both the pressure and the coldness of the ferns in introspection 25, it was the coldness which dominated in the complex and which determined the synaesthetic image. Tactual and kinaesthetic blends, such as roughness, wetness, dryness and the like, have peculiar synaesthetic associates of their own. For example, in introspection 25, *A* described his visual imagery of roughness as darting rays or bands of light which resembled in size and behavior what might have been sparkles from a very large diamond.

Observer B. B's tactual images are exceedingly clear, persistent and real. In their quality and vividness they often closely approximate actual sensations. Other prominent features of his tactual images consist of their wealth of qualitative detail, exactness of localization, the readiness with which long trains or successions of this imagery are aroused and the exceeding rapidity with which attention shifts from one focal detail to another with no apparent loss in clearness, the clarity with which spacial extents stand out in this imagery, and the distinctness with which qualities retain their identity in complex groupings. The *Aufgabe* to recall tactual imagery of objects gives rise at once to complex groupings and successions of tactual images, together with kinaesthetic imagery and incipient muscular movements of handling the objects thus imaged in tactual fashion. Tactual imagery, then, appears in a rich, kinaesthetic setting. It is evident that one tactual image readily leads to another, with no apparent break in continuity of tactual qualities. It is interesting to note that tactual images, themselves, develop much as tactual perceptions develop. As a tactual image begins to run its course there may first appear but one detail or one isolated feature of the object which is to be imaged whereupon further details at once appear, resulting in a full-fledged image which takes in not only the later elements to appear but also the earlier ones. Thus his imagery of a Braille letter began with pressure images of but one point of the letter; this led immediately to imagery of additional points and to a subsequent arrangement of all the points into the appropriate spacial grouping. A clear and definite tactual image of a Braille letter includes the same behavior of attention as occurs in the perceiving of such a letter. When the image has developed to its final stage, individual points lose their identity; within the image they no longer stand out as separate points; attention ignores the individual blunt pressures and is concerned wholly with their spacial arrangement. Thus it would appear that if an image of a complex object is to be complete there takes place in the development of this image a shift from individual elements or ingredients to a fusion or synthesis of these elements, just as takes place in the development of a perception. This shift is equally as rapid and as difficult to describe in the imaginal field as in the perceptual field. This growth of a full-fledged image suggests that in the field of the so-called centrally aroused processes we find a difference between image and idea which corresponds to the difference between sensation and perception in processes which are peripherally aroused. Let us call the individual elements—the separate bluntnesses—which go to make up a full-fledged tactual image of a Braille letter the image elements, and let us call the image in its final stage of development an idea of the Braille letter. Thus we have images corresponding to individual Braille points and a fusion or organization of these images into an idea which corresponds to the perception of the Braille letter as a whole. In the shift from image to idea there develops a spacialized grouping or arrangement of the points just as there develops, in the act of perceiving a Braille letter, this same grouping or arrangement of points. The criterion of an idea as offset against an image thus consists of the same sort of blending or fusing process as takes place in acts of perceiving. This behavior of attention in the development of a full-fledged image is but another way of describing the development of meaning in the image.

iii. Tactual imagery of A and B compared.

1. *B's* tactual imagery far exceeds *A's* in complexity of qualitative detail, clearness, intensity, range of variety, and in continuity of function in groups and successions.

2. There is observable in *B's* case a tendency for tactual imagery to give way ultimately to kinaesthetic processes, while in *A's* case tactual imagery gives way at once to visual imagery.

3. The setting for *B's* tactual processes is kinaesthetic; the setting for *A's* tactual imagery is visual. These settings vary in their function, however. *A's* visual imagery appears concomitantly with his tactual processes; it functions both in the focus and the fringe of consciousness while tactual processes are present. But in *B's* case kinaesthetic imagery is largely relegated to the background of consciousness, under the *Aufgabe* to recall tactual imagery; and in his case kinaesthetic processes do not function as identifyers or as labels for his tactual processes; the latter stand for themselves and occupy the focus of his attention, as such. Tactual imagery, as such, never occupies the focus of *A's* attention. In other words *B's* motor imagery does not "interpret" his tactual imagery and is not inevitably a concomitant of the latter while *A's* visual imagery "belongs" to the tactual and the visual tends to take the place of the tactual at all times and under all conditions.

While *B* is attending to tactual qualities, *A* is ignoring them, as such, and is attending to visual qualities. The quality of pressure, in *B's* tactual imagery, is a quality of pressure and nothing more. The quality of pressure in *A's* tactual imagery *is,* in part, *a visual image,* in that the pressure is not identified in the absence of the visual process. The essential difference between *A* and *B* lies in the act of becoming conscious of tactual imagery. *A* resorts to visual criteria while *B* resorts to tactual criteria.

4. There is a further difference between *A* and *B* as far as their tactual imagery is concerned. We have already described, on page 44, how tactual imagery develops or becomes full-fledged in *B's* case. This process of growth in *A's* case does not involve a grouping or arranging of identified bluntnesses or points which blend or fuse into a purely tactual, spacial extent. This grouping, in *A's* case, involves a dual growth of tactual and visual processes, with the reagent's attention focused upon the visual half of the experience. In other words, step by step, in the development of a tactual image there takes place a corresponding development in visual imagery and the latter throughout interpret or identify the developing stages of the former. Thus, as *A* was aware of the growing tactual image of the Braille *d* described in introspection 25, this awareness was always focally a visual consciousness. We found that in *B's* case the meaning of *d* developed with this blending or fusion of discrete points into a spacial schema and that the spacial schema was inherently and focally tactual, plus kinaesthetic imagery. The corresponding development of a meaningful *d* in *A's* case involved a growth of visual processes. The *d* was not complete until the bluish-green synaesthetic image had assumed the size and shape of the figure *d.* In *B's* case the meaning was tactual-kinaesthetic; in *A's* case it was tactual-visual.

5. These points of difference identify *B* as an asynaesthetic individual and *A* as a synaesthetic individual.

iv. Significance of synaesthetic imagery in A's tactual processes.

As a result of his synaesthetic processes *A* does not live in a world of tactual and motor phenomena as such. His tactual and motor world is *also visual.* It has now become evident that while tactual imagery is present in *A's* consciousness, this imagery possesses no distinct and concrete qualities or features *of its own.* The size and shape of tactual images are represented by a corresponding size and shape in the visual accompaniment; for every implied tactual quality there is a corresponding hue or brightness in the visual associate; duration and intensity of tactual images have their visual counterparts in duration and brightness of the colored associate. The important feature of this synaesthetic process lies in the fact that a color or brightness is selected, in *A's* behavior of attention, as the feature of the experience which is attended-to rather than a tactual quality or attribute *per se.* Tactual imagery cannot stand alone in consciousness and *be tactual imagery.* As long as a tactual process is unaccompanied by a visual image the former is a diffuse, vague, and unidentified experience.

This suggests that all imagery, even in the asynaesthetic individual, undergoes an implicit process of identification if it is to become imagery of any given type, variety, or quality, or if it is to possess meaning. This implicit process of identification or recognition is very obscure and attenuated in the asynaesthetic individual and because of frequent repetition or because of the fact that the identified and the identifying processes take place so quickly in rapid succession or perhaps blend, the identification process is not always introspectively observable. But in the synaesthetic individual the process of identification is always explicit and observable because the identified process is derived from one sense modality and the identifying process from another sense modality. Thus when observer *B* has a tactual image of roughness, that quality, as such, stands out focally in consciousness; the experience is one *of roughness;* the identification or recognition implied by the ''of'' is actually implicit. The processes identified are pressure images; the identifying process consists of a peculiar behavior of attention characterized, perhaps, by a mass of rapid shiftings from one discrete tactual image of a certain clearness and intensity to an immediately adjacent tactual image of another clearness and intensity. But in *A's* case the experience is not one *of roughness* as observer *B* knows roughness; the qualtiy of roughness as such does not develop; the identification implied by the ''of'' is here explicit. The processes identified are pressure images as in the case of *B;* but the identifying process consists of a shift of attention not from one tactual image to another but from a tactual to a visual image. In implicit identification tactual processes in a way identify each other, in part, by means of attention shifts from one to another; in explicit identification the tactual process is identified by a visual image. The functioning of the processes in both instances is the same but the mental contents involved differ radically.

We must not confuse this synaesthetic process with the visual imagery used by an asynaesthetic individual in attending to tactual imagery. An asynaesthetic person may tend to experience visual imagery when he experiences a localized tactual image but here the tactual features of the experience may occupy the focus of attention with the visual imagery entirely non-focal. The tactual feature remains dominant so long as the tactual imagery persists and the visualization of the region where the tactual imagery is projected always remains a secondary process. It may very well turn out that this secondary visual image assists, while it is present, in definitizing the region where the tactual image is projected but the visual image itself can hardly be said to identify the tactual process, as it does in the synaesthetic individual. The synaesthetic character of *A's* visual imagery exceeds a mere tendency to localize the tactual process, visually, for in addition to this tendency to visually localize the tactual image, the quality of the latter and in fact its entire behavior are visualized.

From *A's* field of tactual imagery we therefore obtain added evidence of the possible view that synaesthesis is not only a perceptual process but that it is an imaginal process as well; furthermore we find that synaesthesis is not different, functionally, from processes which occur in an asynaesthetic individual. Introspections on tactual imagery furnish supplementary evidence in favor of the conception that synaesthesis is essentially a process of deriving meaning from sensory data.

d. Kinaesthetic imagery. (Series 1 concluded.)

i. Typical introspective data.

[Instructions: Recall kinaesthetic imagery of tying your tie.]

31. *Observer A.* "(I found that I could obtain motor imagery of movements of my right arm but not of my left. All I could obtain of the latter were the detached visual associates.) As the experimenter read the instructions I was first aware of visual imagery of my collar, localized in its position around my neck, with the long end of a tie extending downward in front. Although the collar was white, no other feature or detail stood out prominently in the image other than its vague shape and its band-like form; the tie was a very dark grey tinged with brown. There then followed kinaesthetic imagery of my right arm making the movement of throwing the long end of the tie over the short end; for a moment only was this imagery clear; attention shifted almost at once to a black visual streak which took the form of a curve corresponding

to the extent and direction of the kinaesthetic image. Then I had motor imagery of reaching under the twisted portion of the tie with the long end, but before this imagery reached the stage of pushing the long end up through the knot the motor features had shifted entirely to the black, visual, synaesthetic imagery. There started to develop at this juncture vague tactual imagery of the softness of the tie as it seemed to rest between my thumb and fingers, but this, also, shifted immediately to its visual associate. There then occurred combined tactual and kinaesthetic imagery of reaching into the 'v' shaped knot from above, as if to grasp the long end of the tie to pull it through the loop. For an instant the kinaesthetic quality of movement loomed up in fairly focal attention, when I experienced the kinaesthetic image of pushing the long end of the tie through the knot and of pulling it tight. The motor quality which became momentarily dominant was the sudden jerk or pull of tightening the knot itself. Otherwise the kinaesthetic quality tended to be dominated by the visual black. And just as this motor jerk developed the visual synaesthetic accompaniment became blacker. I noticed that throughout the entire process this imagery was localized in my right arm and hand; I tried to attend to movements of my left arm, but had only the visual streaks which represented in terms of their own localizations and directions of movement how my left arm would operate in tying a tie. Kinaesthetic imagery was throughout broken into disconnected sections by repeated shifts of attention to the visual accompaniments. I further noticed that it was when I tried the hardest to isolate or single out the kinaesthetic quality of the imagery that the visual processes dominated most. The motor imagery was localized in my elbow, wrist, and finger joints. The chief quality of the imagery was that of change in position with strain appearing only when I imaged the pull or tug of tightening the knot."

[Instructions: Describe the maze which you have recently learned and recall the movements of tracing the paths.]

32. *Observer B.* " The maze was a grooved figure cut from a sheet of tin and tacked to a smooth board. I was aware, first, of tactual imagery of the stylus as it rested between my fingers with kinaesthetic imagery of grasping it; the kinaesthetic processes were the more definite and persistent and involved imagery of finger positions and tenseness about the wrist and arms. In terms of very clear kinaesthetic imagery I was able to recall practically every movement of tracing the maze; the imagery was always that of movement and was definitely localized in my hand, arm and wrist. I vividly felt the constantly changing positions, now down, now up, now around a sharp angle. Throughout, these changes occurred in rapid succession, one image blending imperceptibly into the next; the imagery was very stable, clear, and persistent, with no breaks or interruptions. At the end of the maze I had very vivid motor imagery of the resistance encountered as the stylus came into imagined contact with the termination of the pathway. This latter imagery developed suddenly and rose to a high degree of focality, just as the actual perception would have done. Although there were sounds made in actually tracing the maze, I had no suggestion of auditory imagery in this recall. Consciousness was occupied almost entirely with motor processes with only now and then a suggestion of tactual imagery."

[Instructions: Can you recall motor imagery of the maze which you learned three years ago?]

33. *Observer A.* "(After some little time, during which I was visualizing a very vague and fleeting maze, I think I succeeded in recalling a few isolated movements.) First I was aware of kinaesthetic imagery of holding my arm out in front of me, together with tactual-motor-visual imagery of holding a stylus in my hand, but all of this was very vague and of short duration. Attention was then absorbed for several seconds in vague, varying, and fleeting visual imagery of portions of the maze. There then appeared in consciousness a

motor-visual image of making one of the long and difficult movements in the maze, but the motor qualities were very weak, diffuse and vague, dominated almost entirely by the accompanying visual black which appeared as a developing streak over a fairly wide space in front of me and in about the same position as the maze would have been. I then recalled that I had great difficulty in learning this movement for the reason that I had to come down a straight path toward me and I had the tendency to make that movement in the form of an arc, thus making a great many errors. The motor features of this kinaesthetic image were localized in my shoulder, elbow and wrist and slightly in the muscles of the fore-arm. The former possessed the quality of movement while the latter qualities suggested strain or tension. Together with this imagery I was aware of incipient tensions developing about the jaws and in my throat—the processes which always appeared when I was conscious of making a great many errors while tracing the maze. The usual blackness of the kinaesthetic processes appeared and tended to claim my attention. The tenseness in my throat, jaw, and somewhat in my chest, was accompanied by black visual imagery localized as was the kinaesthetic imagery itself. The localization of the motor qualities, however, was invariably less definite than the localization of the visual black. There was a diffuseness, vagueness and uncertainty about the motor processes which seems to be compensated for by the visual associates."

[Instructions: Recall writing with the point alphabet and describe the imagery involved.]

34. *Observer B.* "First I had tactual imagery of the slate beneath my hand, vague auditory imagery of the sound from the stylus as it punched holes in the paper, and very clear, definite and persistent kinaesthetic imagery of making the movements of hand and fingers as one punches holes in the tagboard; the auditory and tactual imagery was much less clear and real than the kinaesthetic. Clearest of all in the motor imagery were the movements of pressing down on the stylus and of moving my hand along to the next position from which the next hole is to be punched. All of this kinaesthetic imagery was accompanied by incipient movements; in fact the reality of the motor imagery seemed to be proportional to the amount of incipient movement involved or to the extent that I actually felt incipient tensions. These processes were followed by very vivid and persisting kinaesthetic imagery of lifting the slate and of placing it in a lower position on the paper; this latter imagery involved hand, elbow and shoulder. Just as I imaged myself lifting the plate in terms of motor imagery, I had faint tactual imagery of the slate between my fingers, attention, in this latter imgery, being centered upon the perforations in the slate."

[Instructions: Recall the movements of throwing a ball. Describe them.]

35. *Observer A.* "(I can do this only by standing up and assuming a position as if I were about to throw a ball. Otherwise my motor imagery resolves itself into nothing but the visual associates.) I then had, first, a visual image of a baseball in my hand, both the ball and the hand standing out clearly in this imagery and localized in the beginning stage of the throwing position. This was followed by tactual imagery of the ball, chiefly localized between my thumb and first two fingers. The first real kinaesthetic image was that of swinging my arm back into position to thrust the ball forward; this was localized in my elbow and shoulder, principally the latter; there then followed motor imagery of tightening the biceps, very definitely localized for an instant in my biceps and followed at once by a shift of attention to the intense black region in the upper arm—my synaesthetic image. Then I found my attention claimed by a mass of black visual imagery covering my chest, back and sides, but I was unable to isolate the kinaesthetic elements. This meant to me, however, motor imagery of making the final contractions before letting the ball go. I could not obtain kinaesthetic imagery of releasing the ball but was conscious of very fleeting and sketchy tactual imagery of the ball as it was leaving my hand."

36. *Observer B.* Same instructions. "First I had very clear and intense tactual imagery of the ball lying in my hand, loosely grasped. Then followed in very rapid succession, in terms of kinaesthetic imagery, tightening my grasp upon the ball, drawing my arm back, swinging my whole arm around once or twice and then thrusting it forward suddenly as if to release the ball. Most vivid of all was imagery of the slipping or grinding at the shoulder joints and the quick thrust of the forward jerk of my arm. The finger movements of releasing the ball also stood out very prominently. All of this was followed by imagery of muscular tenseness localized in my neck and chest of anticipating the sound of the ball striking against the mit of the person who, by implication, was to catch the ball. Along with these processes there appeared fleeting and dim vocal-motor-auditory imagery, in terms of my own voice: 'Will he catch it?' in rising inflection. This imagery on the whole was so real that I found myself inhibiting actual movements. All of the imagery was accompanied by incipient movements or tensions."

[Instructions: Recall imagery of playing the piano.]

37. *Observer B.* "First, I was aware of tactual imagery of piano keys beneath my fingers but this was accompanied by motor imagery of placing my fingers against the keys and the latter very soon dominated consciousness; there followed very real and intense motor imagery of finger movement as if I were searching for certain keys; particularly clear were the imaged movements at the finger and wrist joints. The quality was that of changing position rather than that of tension or strain. Then I had tactual-motor imagery of playing the first one or two measures of the 'Waltz Caprice', together with auditory imagery of the first few bars but this latter was indistinct, compared with the motor processes. In rapid succession I imaged the positions and movements of my fingers, also the movements of elbow and shoulder as I shifted from one part of the keyboard to another and as I approached the keys with greater or less muscular energy. I was then conscious of sensory tension concerned with the process of anticipating hitting the wrong key as I imaged a sudden and extended movement of my left hand far down the key-board; this latter imagery involved not only wrist and arm but movement of shoulder and back as I shifted my imaginary sitting position in order to reach far enough down the key-board. Together with these latter processes I was conscious of incipient tongue and lip movements which I always have while playing a difficult selection. The imagery was characterized by its persistence, wealth of quality and by its continuity."

[Instructions: Recall the movements of tying a fisherman's knot.]

37a. *Observer A.* "(This is a motor complex which I have not performed for at least five years.) The first processes of which I was conscious consisted of two black visual synaesthetic images of movement in the form of two half circles. Up to this time I noticed that I was in a general state of bodily relaxation so far as incipient tendencies toward movement or tension were concerned; that is, I noted no tendencies to make the incipient movements of tying the knot or of figuring out how such a knot should be tied. Up to this time, also, I was unable to differentiate any real kinaesthetic qualities associated with the black visual images. I then set up for myself the task of making slight movements more or less at random, at first, of tying such a knot. I was then able to recall some of the movements in terms of kinaesthetic plus the visual accompaniments. Here the kinaesthetic qualities of motion and change of finger and arm position appeared in fleeting fashion. (This experiment confirms my observations in general that if I wish to recall old muscular movements, kinaesthetic imagery does not appear until I am able to make the proper incipient and actual movements. These latter seem to set off the old kinaesthetic-visual trains of imagery which could not at first be recalled. Otherwise, without these incipient movements, I can only recall the visual imagery ordinarily associated with the kinaesthetic images themselves. Thus, when I am relaxed or not tending to assume an active bodily or motor attitude toward the task in question, I am much more apt to recall merely the visual black of my kinaesthetic imagery; while if I assume an active attitude, involving incipient movement, I am able to revive the kinaesthetic-visual complex.)"

ii. Summary of introspective data on kinaesthetic imagery.

Observer A. Characteristics of *A's* kinaesthetic imagery may be summarized as follows: The imagery as such is invariably vague, fleeting, difficult of description, patchy, disconnected and very difficult to recall; memories of old and decayed kinaesthetic complexes appear first in terms of detached visual associates; while it appears frequently in *A's* consciousness and is used generally in his imaginal processes in connection with objects or movements recently figuring in his everyday life, this imagery is not attended-to focally; kinaesthetic qualities do not usually stand alone in consciousness but lead at once to stereotyped forms of visual associates; the visual associates of his motor imagery are always very dark or black, the intensity of which corresponds to the intensity of the kinaesthetic feature of the image; these visual associates appear in the form of streaks, bands, or ribbons, when representing movement, and these streaks or bands define the extent, position and direction of the movement itself; the presence of this visual imagery makes it impossible for *A* to obtain unbroken or continuous successions of kinaesthetic imagery as such, for the visual accompaniments intrude upon the continuity of this vague and undifferentiated kinaesthetic consciousness.

The result of voluntary effort to attend to kinaesthetic qualities as such is either a tendency to become absorbed in incipient muscular movement with visual accompaniments immediately rising into the foreground of consciousness, or a tendency to shift directly to the visual associate of the kinaesthetic imagery itself. This dilemma makes it almost impossible for observer *A* to examine kinaesthetic qualities as such. We have found this to be true of his auditory and tactual imagery. When he endeavors to concentrate on sensory qualities other than the visual it always seems as if these qualities were "one step behind attention" while the visual process always seems to be "with attention." Thus qualities other than the visual are always marginal or non-focal; they never become objects of "direct" attention.

Kinaesthetic imagery reveals the same tendency ultimately to give way entirely to visual associates, leaving the latter detached, as was found in connection with tactual and auditory imagery. For example, when *A* recalled motor imagery of throwing a ball during the first few seconds of the recall kinaesthetic imagery appeared together with its visual accompaniment but shortly the kinaesthetic imagery dropped out and the remainder of the imagery of throwing a ball was finished in terms of the visual black synaesthetic imagery, alone.

Noteworthy is the fact that when *A* is relaxed or when he does not tend to make incipient movements, visual synaesthetic images are apt to appear at the outset, alone, as symbols for the motor imagery. On the other hand, if *A* assumes an active motor attitude toward the task kinaesthetic imagery, plus the visual associate, will appear.

There is to be noticed a slight difference between kinaesthetic and other types of imagery in the suddenness with which they lead to their synaesthetic counterpart, as they appear in consciousness. If kinaesthetic imagery leads to incipient movement or is accompanied by incipient movement in any given kinaesthetic complex, *A* then becomes more definitely conscious of kinaesthetic qualities as such and is able to describe them more or less vaguely and indefinitely. For this reason, motor imagery possesses the qualities of movement, and at times, of strain. But in such instances in which kinaesthetic imagery is thus rendered more focal or identifiable by incipient movement, the incipient movement itself ushers into consciousness visual synaesthetic imagery which latter assists in defining the motor qualities. Continuity of kinaesthetic qualities as such is confined to this shift from kinaesthetic imagery to kinaesthetic sensation but since the two tend to appear together and since the kinaesthetic sensation at once leads to a visual image, this continuity is never much more prolonged than it would be in the absence of the incipient movement.

Observer B. Kinaesthetic imagery is by far the type which appears most often and whose qualities are most vivid and persistent. It forms the background of *B's* visual, auditory and tactual imagery. Incipient movement functions as the background or setting for kinaesthetic imagery. So real are his motor images that he often finds himself inhibiting actual movement when the former are present in consciousness. Long trains or successions of motor images occur without interruption or without intervention by images from another modality. *B's* consciousness is never free from kinaesthetic imagery of some sort; and this imagery is the common tool or vehicle which he uses in mediating or controlling imagery from other sense modalities. In fact the very existence of visual imagery in *B's* consciousness seems to depend upon motor factors.

Practically all qualities of kinaesthetic imagery are equally distinct and focal; change of position, rate or speed of movement, strain, jerky, rapid jolts, tenseness—all occupy focal attention at one instant or another in his kinaesthetic-imaginal consciousness. These qualities, however, are invariably reported to be more vivid when accompanied by incipient movement or tension. In fact it was so difficult for *B* to differentiate motor imagery from incipient movement, at times, that we are uncertain where one ends and where the other begins. This fact holds generally, we believe, for kinaesthetic image and sensation.

iii. Kinaesthetic imagery of A and B compared.

1. Both observers agree that kinaesthetic imagery is more stable, more definite and qualitatively more rich in detail when accompanied by or fused with incipient movement.

2. *B's* kinaesthetic imagery far exceeds *A's* in all matters of attribute, and in complexity of implicit behavior.

3. *B's* kinaesthetic imagery functions as a general setting or background for all of his other types of imagery but in doing so the kinaesthetic processes are not claimants of his focal attention until imagery of other modalities gives out. *A's* kinaesthetic imagery does not function as a general background or conscious setting. His settings are always dominantly visual and visually synaesthetic, and the visual synaesthetic imagery is always the claimant of his focal attention to the exclusion of all other modalities.

4. In voluntarily controlling their imagery each observer uses the one type which possesses the greatest wealth of detail or which appears in elaborate groupings or successions. This type is kinaesthetic in *B's* case and visual in *A's* case. It seems that it is the type of imagery which functions as a setting or background of consciousness which is employed in an effort to usher into consciousness or to prolong imagery of other types. For example *A* habitually uses his visual synaesthetic imagery in recalling auditory, tactual and kinaesthetic imagery; a detached visual associate

of a certain tone will suggest auditory imagery of that tone; visual imagery of letters will suggest tactual imagery of letters. The one exception to this procedure is *A's* use of incipient muscular movement in voluntarily controlling his kinaesthetic imagery. *B* habitually employs kinaesthetic imagery in an effort to recall or to control visual imagery; he prolongs his tactual imagery by having recourse to kinaesthetic processes; or he uses vocal-motor imagery in recalling auditory imagery. It is quite evident that the form of imagery which, in each reagent, possesses the greatest amount of qualitative detail and which has come to appear and persist in consciousness most readily, is that type which is not only controlled or mediated with least difficulty but is the type which is used as clues in the voluntary control of other types.

5. One striking difference is to be noted between the functioning of *A's* synaesthetic processes and *B's* kinaesthetic background. The former remain focal as well as marginal as long as they are present in consciousness while the latter remain only marginal as long as other types of imagery tend to claim the focus of attention.

B. SERIES 2*. EARLY AND RECENT MEMORIES.

a. Early memories.

i. Typical introspective data.

[Instructions: Recall some very early memory and describe the imagery involved.]

38. *Observer A.* "(I recalled an incident which happened when, at the age of 4, I was travelling with my mother.) I was first aware of visual imagery of an indefinite extent of water, covering an area of about the size of a city block; the water was smooth and dark green in color; forming a frame for this visual imagery, on one side, were the inside furnishings of a car such as are visible between the car windows, the distinct features of which were shades of dark, yellowish brown. This imagery was at once followed by a focusing of visual attention upon a spot on the surface of the water at which there bobbed up from beneath the surface the head and back of a turtle, with its back turned toward us. Then the turtle was seen to turn about as it swam along the surface of the water and to face directly toward us while its back disappeared beneath the surface. (This was all that occurred in my memory consciousness and the imagery involved was wholly visual.)"

39. *Observer A.* Same instructions. "(I recalled an early childhood experience with a ferocious dog.) First there appeared visual imagery of an open barn doorway; the space in this doorway was for the most part dark with no visible objects except near the bottom of the doorway where I visualized a mass of light, straw-colored stuff covering the floor; I saw no floor around this colored mass but only the darkness which filled the doorway. No detail stood out in this imagery except the color. I then found myself interpreting this mass of stuff as a pile of corn-stalks. To the right of the corn-stalks I visualized a dog, tied by a heavy chain, and sitting quietly upon his

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*Experiments on taste and smell indicate results similar to those obtained in series 1. Owing to the length of this monograph, therefore, these results have been omitted.

haunches, facing me. This imagery was rather hazy as to outline and the only definite features were its sitting position, its dark-tan color except for a patch of much lighter tan on his chest. Eyes, legs, hair, etc. did not stand out in the imagery. Surrounding the dog was a background of dark grey space which became darker a short distance from it and from hence blended into the corn-stalks on the left and into nothing above and to the right, except the darkness which filled the doorway. About the framework of the doorway extended a grey background, filling the remainder of my field of vision. The visualized objects appeared as if I were approaching the door from directly in front. By my side there appeared a reddish brown object which assumed the vague shape of a child companion the color of which meant that my companion was a sister. All of this was followed by visual imagery of approaching the dog and of annoying it with one of the corn-stalks. This was largely an interpretation from a change in the scene; I now found myself, in imaginal terms, directly in front of the dog and between it and the pile of stalks. Then I was aware of intense barking of the dog, not in terms of auditory imagery but purely in terms of vivid yellowish-grey cloud-like forms which issued from the region of the dog's mouth. I also visualized the dog pulling at his chain and trying to reach us. At this juncture the imagery became so vivid that the experience seemed almost real—it became tridimensional rather than remaining photographic as does much of my visual imagery. Then, for a moment the entire region involved in my visual imagery was filled with brilliant but hazy streaks or ribbons of light, colored a silvery white with reddish and 'creamy' spots. This latter imagery represented my sister's screams but there was no auditory imagery present. The whole memory was exceedingly clear but of short duration. (Each time I recall this experience this imagery tends to appear in the order described above; and so far as I can tell, it has not changed in detail or quality for years.)"

40. *Observer A.* Same instructions. "(I recalled my first visit to the Blind School, at which time I was escorted about the grounds and through the buildings by the superintendent's wife, who told me about the things I would learn and how I would study geography and other lessons.) At the outset I had visual imagery of the expansive grounds; this consisted first of a winding cement sidewalk, of a broad expanse of yellowish-brown, dead grass with trees scattered here and there on both sides of the walk. This imagery was photographic and possessed almost no detail. I could not make out the individual blades of grass; the area in my image, covered by the dead grass, was a smooth, washed color; the trees to the right and to the left were seen as if I were approaching the school building from along the walk; the scene shifted as I imagined myself advancing toward the school itself, although I had no motor imagery of walking; I found myself attending to no particular tree; only the trunks and lower branches of the trees were visible; above, the imagery merged at once into nothingness or at best a vague setting of neutral grey. The trunks of the trees had no definitely outlined shape or size and the branched portions which were visible were a poorly saturated darkish green. Here and there only did much detail stand out for mostly mere areas of color represented the green portions of the trees; this color, however, was sufficiently definite and characteristic to tell me that the trees were fir. Then I had faint and fleeting visual imagery of the superintendent's wife standing before me; the image assumed the general shape of a human form the distinct feature of which was its color and brightness—a certain light yellow. (At this juncture in my memory, I recall that she told me that she was going to show me about the place; but here I had no auditory imagery. This is an interpretation. I remember, also, my feeling reaction at the time which now consists of a reinstatement of an organic complex.) I was next aware of a sinking sensation somewhere in the region of my stomach or abdomen—I think diaphragm; of an incipient tightening about the back and shoulder muscles as if I were beginning to resist something; there was nothing in my visual imagery which might suggest an

unpleasant reaction but at the time of the incident I judged the superintendent's wife as regal and cold; I now recall this feature of the experience in terms of verbal interpretation and of the organic reaction which I have just described. Next I had visual imagery of being on the back porch where I visualized a hammock which one of the pupils at the school had just finished making. Then the scene changed to that of a school room; I saw, in my visual imagery, one end of the room; my attention was first centered upon a globe which was about three and one-half feet in diameter; the visible surface of the globe was washed with a dull waxy-like green light, regions of which represented water and the darker regions of which represented land and mountains. Behind the globe I visualized a plain grey wall with no detail. From here my attention shifted to visual imagery of dissected maps lying on a desk; I saw the sections distinctly, lying there in their different shades of natural wood color, but further than this no details were present. I recall now, indirectly, that I inspected these pieces at the time and marveled at the fine workmanship involved in making them. This, however, comes to me in verbal fashion. Throughout the whole experience, attention shifted from one visual image to another without pause and without any slumping in attention. (By voluntary effort I am now able to construct tactual and motor imagery but during the spontaneous recall no such imagery was present.)"

41. *Observer B.* Same instructions. "(The first memory which entered my mind upon hearing the instructions was that of going to a public school before I lost my sight. I snatched a stick of candy from a playmate while on the way to school, and ran away with it. In recalling the incident I had no visual imagery whatever. Practically all of my imagery consisted of verbal processes having to do with relating the experience.) I was first aware of this memory in terms of an incipient verbal image, 'school,' followed by incipient motor imagery of arm-movements of grasping what I later interpreted, verbally, to be a piece of candy; I then had kinaesthetic imagery of leg movements of running. (I suppose that practically all of this imagery arises in the process of recall, not from memory, but from the process of relating the incident. I feel I had no real memory imagery of the experience at all.)"

42. *Observer B.* Same instructions. "(The most vivid of my early memories is the recall of my accident.) At the outset I had a fleeting visual image, suggested by an antecedent verbal process, 'accident,' of the house across the street from the place where the accident occurred; for the briefest flash of a second this image was vivid and real but it disappeared almost as soon as it came. This imagery included a small section of a muddy street, part of an old wooden fence in front of the house, the dull wintery sky overhead and a snow-covered hill in the background. This imagery lasted for so short a time that I perceived these objects as wholes and was aware of no particular details. Next I had motor imagery of groping about, immediately following an (implied) explosion; then followed kinaesthetic imagery of stumbling and tactual-kinaesthetic imagery of being held in the arms of a companion who ran to me. A host of imagery then followed, including auditory imagery of my father's exclamation when he first saw me, of my mother's voice and of a friend's who was present when I was taken home; kinaesthetic imagery of sitting in a chair in the kitchen (kitchen interpreted) while my mother washed my face and hands. Accompanying this was faint, fleeting visual imagery—merely a shadow—of my friend. Accompanying this imagery were affective-organic processes which invariably recur as I think of the accident. These involve tendencies toward changes in respiration, tensions in the muscles of my chest, throat and face."

43. *Observer B.* Same instructions. "(I have recalled my first visit to the blind school.) In the beginning I had auditory imagery of my mother saying:

'We are here.' This was followed by distinct and intense auditory imagery of the teacher's voice telling me that I would learn to make different things; then came fleeting and faint tactual imagery of bead baskets and other kinds of baskets, kinaesthetic imagery of moving my hands over these and other objects. (From this point on I am not certain that I am really recalling events which actually took place at that time.) I then found myself constructing tactual and kinaesthetic imagery of objects of various kinds—cane-seated chairs, hammocks, games and the like. These images lack the background consciousness of recognizing or of labeling my experiences as old, familiar events."

ii. Summary of introspective data on early memories.

Observer A. We are not interested in discussing early memories as such for the reason that our principal purpose is to comment upon the appearance of synaesthetic processes in *A's* consciousness of early childhood events. The imagery of his early memories is throughout entirely visual. Only as his visual contents suggest verbal associations or verbal acts of interpreting these contents, is *A's* early memory consciousness characterized by any other modality than the visual. The most prominent features of this visual imagery consist of their photographic nature, their emphasis upon color and degrees of brightness, their invariable visual setting of neutral grey, their dim, indistinct outlines and lack of minute detail. The most interesting feature of *A's* early memories is, for us, the fact that colors and shades of brightness stand alone in consciousness as representatives of auditory, tactual or other non-visual experiences which he had at the time. This fact indicates that *A's* synaesthesia developed very early in childhood; so early in fact, that his very oldest memories are synaesthetic.

In an incident during which *A* and his sister annoyed a dog, chained in a barn, *A* heard the barking of the dog and his sister's screams but these sounds are not remembered in terms of auditory images. At the time of the incident these sounds were colored. The colors are remembered but not the sounds. Striking is the fact that the behavior of these dissociated or detached colors faithfully describes the intensity of the dog's barks and the intensity and fearfulness of his sister's screams. The affective reaction which *A* experienced at the time and which has been forgotten, as such, is now recalled in terms of its detached visual accompaniment. These dissociated synaesthetic images appear in a visual setting which assists in ascribing to them their proper meaning in the absence of the imagery for which they stand. They are also interpreted concretely by verbal processes. Vocal-motor imagery functions also in filling out other deleted contents. For example, *A* recalled that he picked up a cornstalk and threw it at the dog but has no direct memory imagery of doing so. This item appears as a verbal process in relating the incident.

Observer B. B's early memories are visual, auditory, tactual and kinaesthetic in their contents. His very earliest memories are exceedingly attenuated and fleeting and are so lacking in direct content that practically the entire process of recall consists of the verbal processes having to do with the relating of the incident. None of these imaginal contents of early memories possess the richness of detail, nor the durability of ordinary processes of imaging objects or events, with the one exception of the visual which possesses greater definiteness and quantity of detail in early memories than in any other functional group of *B's* mental contents. But such visual images as do occur in early memories appear and disappear with a flash and only in rare instances can they be revived or prolonged. The fact that more visual imagery is present in his early memories than is present in his thinking processes in general may be explained on the ground that at the time of these early events *B* could either see or he had vivid visual imagery. It is of importance to note that detailed or clear visual imagery appears only in certain contexts and that these contexts are those which developed at a time when *B* employed visual processes. This suggests that the ability to arouse or to employ imagery of certain types, generally, depends upon the development of certain definite contexts in which the desired image and the cue which is used in ushering this image into consciousness must be such as frequently appear together in consciousness. Thus *B's* visual images, in early memories, are more or less detached phenomena; they are images which have no specific value in his conscious life, relatively speaking; they, as well as the cues which arouse them, appear relatively infrequently; the one will not appear without the other. It would be interesting to speculate whether the fact that *B* can have fairly distinct visual imagery in early memories and not in ordinary thinking is really due to a decay of his visual modality or whether it is simply due to the fact that because of the continued absence of visual sensory processes he has formed habits of developing only such contents—complex groupings or successions—as are constantly functioning in sensory experience proper. We are inclined to believe that if his visual modality were decaying we would find evidence of it in *every* visual image, and that the presence of clear and detailed visual imagery in one context means that visual contents, as such, have not decayed. It points to the fact that the functions of developing contexts in which visual imagery appears have decayed rather than contents *per se.*

While this observation is not a new one in the psychological literature, its importance has not, evidently, been appreciated. It throws light upon the much discussed problem of act and content. It indicates that contents and acts are mutually exclusive data but that they are dependent variables. The one cannot exist without the other. The content is the mode by which the act takes place. Any act or event must take place in a certain mode and by this mode we mean the method or procedure by which the action takes place. The content is the *form* of the act. The former is inevitably structure, *i. e.,* it is static while the latter is inevitably function—it is dynamic. In crude language the content is the thing which is acting. But the content is in a last analysis a practical and arbitrary abstraction whose limits must, in actuality, be as flexible as the act of which it is the form. In other words mental contents are the forms in which mental activities exist. If a content has decayed it implies that a function has likewise decayed and *vice versa.* It would be misleading to say that *B's* visual modality has decayed, for it presumes that his mental functions have throughout remained intact. With decaying mental contents —if they have decayed—there has occurred a decay in such processes of abstracting data from habitually used experiences as will supply contents for further experiences. A deleting in *B's* processes of abstraction has occurred together with deletion in visual imagery. If decay in visual imagery has occurred this decay has taken along with it corresponding processes of attending, associating, controlling, deriving of meanings, recognition and the like, all of which have been supplanted by similar functions dealing with images in other modalities. As a result of this dual decay—if it can be called decay—we should expect that deletion in processes of associating, controlling, deriving meanings, recognition and the like would force *B* to develop new contexts in which visual imagery would not and could not appear and that wherever visual imagery does appear it of necessity exists only in such contexts in which it can be associated, controlled, and recognized. *B's* early memories are isolated contexts as well as contents; they are isolated functional as well as structural groups. This, we believe, explains why detailed visual imagery appears in one conscious setting and not in another. With the loss of visual imagery go the cues which will arouse this imagery; such visual imagery as does persist is only that imagery whose cues have not likewise disappeared. Contents which are present in the context of early memories provide these cues and no other cues will suffice to arouse this visual imagery.

We find evidence of all this in *B's* early memories themselves. Not only is visual imagery fleeting and uncertain but also is the entire early memory consciousness. Where contextual imagery from other modalities is definite so is the visual; where contextual imagery is lacking, so also is the visual; where the visual image itself is definite there is a cue which suggests it; where the visual image is lacking there is also lacking the cue which will suggest it; other cues fail to produce the image, to prolong or to revive it. In the absence of old processes of associating, attending, controlling, and the like, all of which have gone with the visual imagery itself, *B's* mental procedure, during the act of recall is, of necessity, concerned with new and other things, namely, verbal processes of interpreting, processes of supplementing, constructing new contexts, and the like. Hence we find him relating in terms of vocal-motor imagery the incident of having snatched a piece of candy from a boy companion when he was on the way to school at a very early age; we find him tending to fill out the memory of his first visit to the blind school in terms of tactual and kinaesthetic imagery which he is certain is not direct memory imagery. Old contexts disappear and with them the old contents and in their places appear both new contents and new contexts. Whether the old have decayed or have merely become detached from the proper cues for their arousal is but a matter of speculation.

iii. Early memories of A and B compared.

1. While *B's* early memories contain relatively more visual contents than do groups of images which appear in other contexts, *A's* early memories show no such marked difference. It seems probable that the latter's visual imagery has been kept ''alive'' both by his entoptic phenomenon and by his constant use of visual imagery in synaesthetic phenomena and in synaesthesia proper.

2. *B's* early memories have undergone processes of deletion or degeneration of a type which is not to be found in *A*. Owing to the dropping out of visual contexts in *B's* everyday experience we believe that not only visual contents but entire functional constellations have disappeared from *B's* mental life and that these constellations involved the cues necessary for the arousal of visual contents. But in *A's* case, owing to synaesthetic functions and to an entoptic phenomenon from both of which he has been able to abstract contents for future use, cues and contents, alike, have been retained. Undoubtedly *A's* early memories have undergone processes of attenuation and perhaps of elaboration as have *B's* but the former's visual contexts have remained intact throughout his mental life. He has not, like *B*, suffered dissociation of visual functions to the extent that visual imagery appears only in a small group of contexts having to do with early memories.

iv. Significance of synaesthetic phenomena in A's early memories.

A's early memories throw added light upon the evident value of his synaesthetic imagery. That sounds, affective states, and in fact all forms of non-visual experiences should be retained in terms of their detached visual associates is consistent with our view that in his case non-visual experiences cannot be attended to as such. This means that they cannot be experienced as such and therefore that they cannot be revived or recalled as such. Since, therefore, all non-visual images are vague and undifferentiated experiences until they become visual, they are unstable and subject to early decay or dissociation from their visual accompaniments. An experience that is to be recalled must be one which can be voluntarily controlled or one which is subject to arousal by the method of cues. Unstable and easily dissociated processes are less subject to control by means of cues. On the other hand the visual associates are stable; they are stereotyped and being concrete, definite experiences as well, they are the processes which become more strongly integrated into various patterns of response. They are the processes, then, which are more subject to voluntary control. As a result of these conditions we should expect, then, that the visual rather than the non-visual half of a synaesthetic experience would be the one which is retained. In other words that half of the synaesthetic experience is retained to which definite attributes, qualities and meaning are originally ascribed, and since it is to the visual half of the synaesthetic experience to which definite qualities and meaning are ascribed, it is the visual image rather than its vague and meaningless parent process which survives in the memory context.

The visual image, in any given synaesthetic experience, is stronger than its parallel sensory process. We have already seen that in synaesthetic phenomena the associated image is stronger than the parent image. It is the associated visual image which claims attention rather than the non-visual half of the process. As we shall see later, the same condition obtains in synaesthesia proper, *i. e.*, when the primary process to which the image is attached is a sensation rather than an image. It is not surprising that the stronger of the two factors in synaesthesia should survive and that the primary but weaker factor should decay or disappear in the process of forgetting.

b. Recent memories.

i. Typical introspective data.

[Instructions: Recall a recent incident and describe in detail all of the imagery involved.]

44. *Observer A.* "(I recalled a fishing incident which occurred about a week ago.) I first had visual imagery of myself standing in the rear end of a boat about half of which was visualized as being the drab color of water-soaked wood. I was holding a fishing rod in my hand. Out in front of me was stretched a smooth, level expanse of greenish-olive colored water and at the far end of this expanse, about fifty yards away, I visualized a bright, white cloud-like 'bank'; over this 'bank' I was rapidly moving my line of regard and could detect slight kinaesthesis of eye-movement as I did so. This white 'bank' represented rapids farther down the creek. The shores of the creek were visualized a grey and were indistinct save for the fact that they were definitely projected about 50 feet from me on either side. Above me I was dimly conscious of something black; I had kinaesthetic imagery of crouching beneath it. This black mass meant to me overhanging willows and alders into which I had been fouling my fishing tackle. The willows and alders were visualized in the same black as accompanies kinaesthetic sensations and I am certain that this was due to the fact that this visual imagery was affected by the accompanying kinaesthesis of avoiding the branches and by the tensions having to do with imaged crouching movements and fear that my fishing tackle would become fouled. Together with this kinaesthesis there appeared distinct organic images, colored, of unpleasantness. These were localized from my shoulders down to the region of my belt. Then I recalled two distinct pulls at my pole. Thereupon I recalled kinaesthetic imagery of tightening my muscles in my arms and chest while at the same time I visualized my hands upon the pole and myself working the reel. There accompanied these latter experiences a projected tactual-like image out in the water at the end of the line. This projected tactual image consisted of two dark blots out upon the greenish-olive water. (This imagery puzzled me for a moment. I am unable to identify it either as tactual in origin or as kinaesthetic. If it is tactual-pressure in origin why should it not be localized in my hands where there was nothing but purely visual imagery of white hands? If it was kinaesthetic why wasn't it localized in my arms? But watch the development of this projected image.) I next recalled a sound of a splash coming from the region at which these two dark blots had been visualized. This splash appeared as

a white spire-like form of brightness about a foot high and extending upward from the green surface of the water. I identified this as a pure synaesthetic image for the reason that if it had been a visualized splashing of water instead of a symbol for the sound of the splash, there would have appeared concentric wavelets irradiating out from it. Immediately in front of this visualized auditory splash I visualized the head and gills of a fish, with its mouth open—just as a fish appears when fighting a hook. Before this visual image of the fish became definite in outline and clear as to details it was obliterated by a black streak, irregularly formed like the tongue of a lightning flash; this black streak shot out and away from the place at which the fish-head had just been visualized and behaved on the surface of the water very much as a shadow would behave upon a screen which moved about. This movement of the black streak I at once interpreted as the movement and progress of the fish from place to place beneath the water. I then recalled attempting to check it with arm-movement; this latter consisted of kinaesthetic imagery of arm-movement together with incipient tensions. Here, again, the movements of the fish seemed to be colored by my kinaesthesis of trying to check these movements. The entire experience through here was rendered more vivid in color due to the unpleasantness from the overhanging branches and also to anxiety concerning my old last year's fish line which was not in the best of condition. The unpleasantness appeared in the form of fleeting organic sensations which in themselves were more or less indescribable other than as to their bodily localization in jaws, shoulders and chest; but they were followed at once in consciousness by vivid dark browns and blacks. The kinaesthetic element in this affective toning is very strong and shows up clearly in the blackness of the visual associates. Both organic and kinaesthetic processes disappeared before the visual, leaving the latter as visualized regions about my arms, shoulders and chest. I then recalled synaesthetic imagery of my own voice—a poorly saturated bluish-brown, but I was unable to recall what I said. By this time the olive-green water had become very much 'streaked' with these lightning shaped ribbons of black, requiring considerable eye-movement to follow them out to their terminations. Then, very, very suddenly all of these streakings vanished and again appeared the smooth expanse of olive-drab water. I visualized myself lifting the pole until it nearly touched the black, visualized overhanging trees and out from the water where I had been seeing the black streaks appeared about 18 inches of a bluish fish-line with the end dangling above the water about six inches. At the very tip of the line appeared a small, brilliant white light which was interpreted as the broken end. (I forgot to mention that the fish's head was visualized as a bluish-white. I am now convinced that the two black, projected blots at the end of the fish-line were projected visualizations of the two sharp tugs on the line as the fish was biting. They were colored black owing to the influence of my black kinaesthetic synaesthesis.)"

45. *Observer A.* Same instructions. "(I recalled a recent ball game which I attended.) There first appeared visual imagery of the ball ground stretched out before me; I recognized features about the field, however, which indicated that it was not the ball ground to which I recently went which I saw in my imagery but a field which I used to play on when a boy. No detail stood out in this diamond-shaped field until my visual attention was claimed by the region about the home plate; then there appeared the background of fir trees and the broken-down fence beyond the out-field. The trees were not distinct as to outline but merely green, conical shaped forms; the fence consisted of rather blurred rod-like bands of grey—the color of weatherbeaten boards. I could not see the players other than as vague moving forms of dark grey; I then saw myself sitting upon the bleachers. (When I attended this particular game I did not visualize the field before me but the field which I have just described.) I could not get any auditory imagery of the sounds from the players or from the grand-stand, nor did I have any memory imagery of climb-

ing onto the bleachers, but I had fairly definite images of face-like shapes thickly distributed about me and among some of these faces I recalled familiar colors representing certain individual persons whom I knew. I was able to see the general shape of certain faces but these forms had no other detail other than their peculiar coloring. Unfamiliar faces were mere round forms of grey. The faces which stood out the clearest were those of students who rooted the hardest and whose voices I recognized during the game; the faces are colored according to the colors of these voices. All of this was followed by developing tendencies to visualize my legs in a very light-grey color; as I fixed my attention upon this imagery for a moment there developed faint tactual imagery of the cold wind, blowing against my legs, whereupon this light-grey imagery became much brighter. Then I visualized wide black streaks across the middle of my back and in the lombar region; this constituted my remembrance of back strains as I sat for a long time upon the bleachers with no support behind me; this latter imagery in turn was followed by kinaesthetic imagery of these back strains and again the color was made more intense. As I lingered upon the kinaesthetic qualities, however, which at first were very indistinct, they tended to give way to visual qualities entirely, which latter persisted much longer."

46. *Observer B.* Similar instructions. "(I recalled a certain portion of a walk which we took not long ago, through a wooded section of country and over a winding trail.) First there appeared auditory imagery of the footsteps of the man who was walking in front of me; then sketchy auditory imagery of his voice in which the peculiar pitch and timbre of his voice stood out rather than any particular words which he said. This was followed by auditory imagery of the footsteps of the man behind me; the latter were characterized by their heavier thud as his feet struck the ground. Then followed in very rapid succession a mass of imagery; kinaesthetic images of walking up the steep slope of a hill; kinaesthetic imagery of swinging my arms, motor imagery of deep breathing-in of the fresh air, auditory imagery of a bird singing, tactual imagery of a flower which I carried for some time while on the walk; olfactory imagery of the flower, auditory imagery of a windmill which I heard off in the distance, auditory imagery of a cow stepping aside from the trail as we passed her by, auditory imagery of the cow's breathing, vocal-motor imagery of my voice saying, 'Gee! this is great!' and along with this latter imagery I was aware of slight tendencies to breathe more deeply during the recall, of tendencies for the muscles all over my body to become tense with exhilaration as I imaged the great expanse and freedom of the out-of-doors. Included in this organic and motor response were tendencies to crane my neck as if I were looking or listening to something far off in the distance. All of these images were so vivid and real that I tended to repeat the actual movements of walking as I was in the process of recalling the incident. While each image was fleeting, it was very clear and intense while it persisted; attention shifted suddenly from one process to another with almost no perceptible lag, during the entire procedure."

47. *Observer B.* Similar instructions. "(I recalled the last time I occupied the pulpit of a small country church.) I was first aware of auditory imagery of the organ playing a hymn, together with auditory-vocal-motor imagery of joining in the chorus with the congregation. This was followed by diffused tactual imagery of the warmth irradiating from a stove which stood near the pulpit, tactual imagery localized in my hand and forearm of resting against the top of the pulpit and tactual imagery of hitting my knees against the sides of the pulpit; then there was vague imagery which I presume was tactual, of the carpet beneath my feet; I recalled the people in terms of auditory imagery of the rustling of their clothes and in terms of rustling paper and books; I also had a confused tactual-motor-visual image of the church auditorium, resembling one's consciousness as he is approaching a wall; in this complex I vaguely distinguish a blank, shadowy form before me, faint coolness

and a low jumble of hardly distinguishable echos from the noises in the air. I then had distinct memories of the benches, partly visual, in the form of fleeting shadows, the only clear feature of which was the fact that these shadows appeared as curves aligned in a row; together with this latter imagery I had kinaesthetic imagery of arm-movement of feeling along the arms of the benches as I walked by. I had incipient motor tendencies of turning to the right which constituted an awareness that the organist was in that direction, but before this process developed to a focal degree of clearness I had hosts of kinaesthetic and tactual images concerned with feeling of the pulpit and with pacing back and forth behind it as I preached the sermon. During the process of this recall I had numerous incipient tensions about the face, neck, shoulders, arms and chest, together with visceral disturbances, all of which constituted the affective side of my mission in the church."

ii. Summary of introspective data on recent memories.

Observer A. The contents and functions alike are almost entirely visual in *A's* recent memories owing to the fact that during the original experience of the event recalled he is constantly translating non-visual experiences into visual images. Throughout his recent memories sounds, tactual experiences, kinaesthetic processes and in fact all non-visual experiences are recalled in terms of their dissociated visual symbols and these symbols are invariably identical with the visual imagery which was originally associated with the non-visual experiences. Of importance is the fact that at times these dissociated visual symbols suggest their parent processes. For example in recalling the experience of fishing *A* was first aware of a black mass over his head, colored black owing to kinaestheses of avoiding this mass which represented willow and alder branches above him. Then there appeared kinaesthetic imagery of crouching to avoid the over-hanging limbs. At another time *A* was aware of visualizing the calves of his legs in terms of light grey whereupon the parent process of this light grey appeared—a tactual image of the cool wind blowing against his legs (as he sat upon some bleachers watching a baseball game). At other times, however, the parent process does not appear. For example, in terms of the original visual concomitant, not in terms of auditory qualities, he was aware of "auditory imagery" of a fish splashing in the water as it was hooked. Or again, he had visual imagery of his own voice but no vestige of auditory qualities. In the process of forgetting, therefore, it is evident that *A's* auditory processes become dissociated from their visual accompaniments much earlier than do tactual and kinaesthetic qualities. And since kinaesthetic qualities appear in his recent memory content more frequently than do any other non-visual processes it seems safe to conclude that kinaesthetic processes are less affected by dissociation than are processes from any other non-visual modality. It is significant in this connection to note that kinaesthetic processes have more definite features or attributes of their own than do any other non-visual experiences. *A* occasionally reports a fleeting but "pure" kinaesthetic image and by this he means that kinaesthetic qualities as such momentarily tend to become focalized in consciousness—a state of affairs which obtains for no other non-visual type of image. Nevertheless *A* cannot attend to a kinaesthetic process as such in the absence of its visual associate of blackness. There is no doubt, however, that qualities of tension, strain and movement may, momentarily, if but non-focally, be ascribed to kinaesthetic processes as such.

Thus it seems that while in his early memories *A* is unable to recall any original non-sensory experience other than in terms of its detached visual associate, in his recent memories *A* is able to recall the entire synaesthetic complex—the visual associate together with the parent, the non-visual process. If, however, the parent process does not appear along with its visual associate, the only procedure by which *A* is able to recall the former is by resorting to the method of fixing his attention upon the latter. It invariably happens that when the visual associate is lacking so is the parent process and the parent process can never be revived in the absence of the visual associate. Wherever a synaesthetic phenomenon appears in a memory consciousness it enters consciousness as one process; that is, provided the non-visual half of the phenomenon appears first it is never detached but merges very suddenly into the visual accompaniment.

Detached synaesthetic images function quite generally in *A's* processes of recall as the cues by which he obtains imagery of the primary and non-visual half of the original experience. If, for example, he wishes to recall the name of a certain person, the color which symbolizes that name will appear first and the name itself will be derived from the hue, shape, brightness or behavior of the visual cue. Thus in recalling past experiences synaesthetic phenomena are reversible; the presence of the detached visual image may lead at once to the advent into consciousness of the non-visual half of the original experience. The visual associate tends to appear first and then ushers into consciousness the primary image for which it stands. In synaesthetic phenomena, then, the association may run in the direction of the secondary to the primary process in the case of recall but runs in the direction of primary to secondary process under conditions which do not involve recall. Observer *A* has become so familiar with large numbers of his stereotyped visual images that he can at will employ them as memory aids and does so constantly in conducting his classes in history, biology and in general science.

Notwithstanding this fact that synaesthetic phenomena are reversible, certain investigators in this field have affirmed the irreversibility of synaesthesia and as a consequence have been led to adopt a physiological theory. (See II, page 38.)

Observer B. *B's* recent memories are exceedingly rich in tactual auditory and kinaesthetic details, the kinaesthetic imagery tending to dominate and to be more definite and persistent than the other forms. Visual imagery is exceedingly rare and wherever present it is fused with tactual or motor processes; it is confined to shadowy forms or vague greyish extents of space and functions almost wholly in tactual-motor schemata. In other words, visual imagery is limited, in function, to contexts which have to do with awareness of space or extents as such. This suggests that one of the most stable of all of the visual attributes and perhaps the most primitive, is the attribute of extent. And since *B's* visual imagery is largely confined to greys, so far as brightness is concerned, brightness seems to follow extent as a next most stable or primitive attribute.

In his recent memory consciousness *B's* attention shifts with great rapidity from one qualitative detail of content to another, each quality as such standing out momentarily in consciousness.

iii. Our observers' recent memories compared with their earlier memories.

A's memories, throughout, are dominantly visual in their content. Old auditory, tactual and motor processes have become dissociated beyond voluntary control and only the visual associates have survived. As we examined his recent memories we found evidence that certain of the original tactual and kinaesthetic experiences had not yet "decayed" to the extent that they could not be recalled, although many of them had already become dissociated from their visual concomitants to the extent that only by having recourse to the latter, which readily appear in consciousness, could the former be reinstated. But auditory experiences which dated back but a few days could not be recalled; only their detached visual associates would appear. Auditory imagery seems to be the first to suffer dissociation while kinaesthetic imagery is the last of the non-visual experiences to undergo such dissociation.

A change has occurred in *B's* memories as we pass from early to recent forms. But in *B's* case this change consists of a dropping out of visual imagery and of a gradual increase in the relative importance of kinaesthetic imagery.

As a consequence of these changes in both reagents—the diminishing amount of dissociation of synaesthetic phenomena in *A's* case and the increasing importance of kinaesthesis in *B's* case—we find a clue to the procedure by which images are aroused during the process of recall. *B's* kinaesthetic images function as stimuli for the arousal of tactual and auditory images while *A's* important cues are visual and are used in arousing tactual and kinaesthetic imagery and in unsuccessful attempts to arouse auditory imagery. *B's* visual functions seem to have decayed; *A's* not only have been retained but are functionally more useful as cues in his recent than in his early memories. Thus the lack of visual imagery in *B's* case and the dominance of it in *A's* case have produced opposite results. While this fact is in itself obvious, its importance in aiding one to understand the significance of *A's* synaesthetic phenomena cannot be over-estimated.

iv. Significance of synaesthetic phenomena in A's recent memories.

Results from *A's* recent memories confirm our interpretations from results on his early memories. (See page 62.) Not only are the visual associates far more stable and subject to voluntary control but they themselves are used as the means by which voluntary recall of non-visual experiences is exercised. These results also confirm our tentative view that synaesthetic processes function in the development of meaning. For we found that where one half of the synaesthetic process stood for the other half, one of these paired associates inevitably tended to lead to the other so long as the members of the pair had not become dissociated in the process of forgetting. And it made no difference which of these two associates appeared first in consciousness. In other words, where meanings are reversible, so are synaesthetic phenomena.

Synaesthetic phenomena function in recent memories as they function in imagery and in early memories: the attributes of non-visual processes are ascribed to stereotyped concomitant visual imagery; and as a result, when this imagery becomes detached temporarily from its non-visual parent process it symbolizes or *means* that missing experience in that it may function in a meaningful complex of mental events just as if it were the original non-sensory process itself.

Still further evidence that synaesthetic processes play an important rôle in the development of meaning is to be found in the influence which the synaesthetic function may have upon such visual imagery as is not normally synaesthetic in character. In *A's* recent memory described in introspection 44, visual imagery of willow and alder trees was colored black when it normally would have been some shade of green and brown. The instant after this visualized blackness of the trees above him had appeared in consciousness *A* found himself becoming conscious of kinaesthetic imagery of crouching to avoid the branches. The kinaesthetic processes were anticipated in terms of the black synaesthetic image which always means kinaesthetic qualities when present in certain contexts. But when the black synaesthetic imagery appeared first in consciousness it was localized above him in the mass of trees which was to be avoided by means of muscular movement. Similarly the visualized movements of the fish which he had hooked were rendered black before kinaesthetic imagery of pulling on the line appeared in consciousness, and remained black throughout the subsequent presence of this kinaesthetic imagery. Again, kinaesthetic imagery of the tugs on the line as the fish struck the hook was represented in consciousness by visual synaesthetic imagery not localized in the usual fashion in the region of the muscles involved but projected out to the end of the fish-line as two black blots. In each instance the quality of black was the forerunner of a kinaesthetic image, and with the exception of the two black blots projected out at some distance from the observer on the surface of the water, the quality of black meant an *anticipated* kinaesthetic image. One would have expected that if *A* were about to anticipate a kinaesthetic image he would have visualized the willow and alder trees, the movements of the fish and the tugging of the fish at the end of his line, all in ordinary fashion and in their natural colors, and would then have had visual imagery of blackened regions localized in the musculature involved in the subsequent kinaesthetic imagery. But there was evidently a process of foreshortening in his mental processes. He left out the black regions localized in the musculature and instead, blackened the antecedent visual imagery. One might interpret this state of affairs as a process of attenuation or short cutting in *A's* mental functions where synaesthetic processes are involved; or one might assume that a process of irradiation has taken place in a forward direction in the particular response pattern which involved, for example, willow trees and crouching movements. Whatever may be the particular method by which synaesthetic functions thus affect adjacent mental contents in any given complex of imagery it is evident that we here find a situation similar to that described in introspection 6. We there noted that visual imagery of a particular person was identified in terms of the same color which appeared in connection with that person's voice. We found that all imagery having to do with that particular person was affected by this same color, obviously pointing to the fact that the color had to do with *meaning.* So in the peculiar functioning of synaesthetic processes which we have just been considering, willow trees *meant* something to *A* aside from being mere willow trees; they were trees-to-be-avoided-in-kinaesthetic-fashion and this meaning was present in terms of trees visualized in black—the black of the forthcoming kinaesthetic imagery of crouching. The movements of the fish meant to *A* movements-to-be-checked and were thus colored the black of kinaesthetic movements of pulling on the line. The black blots mentioned above present a similar problem.

Accordingly *A* did not have to stop and think: "Here are willow trees which are very close to my head and therefore if I do not crouch down I will hit them or my fish tackle will become fouled." The meaning of the entire siutation was reduced to its simplest terms—*black* trees. The visualized movements of the fish meant more than mere movements of the fish. The movements were *black* and thus they meant: "The fish is darting rapidly about in the water; I must keep the line taut." Such is syncopation in meaning *par excellence!* As visual imagery of a person is colored and thus comes to mean imagery-of-a-*certain*-person, so imagery of a willow tree and the movement of a fish come to mean, in a memory consciousness, objects-which-were-responded-to-in-*certain* fashion.

C. Series 3. Imagery in constructive imagination.

i. Typical introspective data.

[Instructions: Imagine yourself standing upon the corner of 25th and Broadway, New York City, and give a complete introspective description of your mental processes.]

48. *Observer A.* "(I assume that I was standing on the curb for the reason that I was aware of people passing behind me and of the traffic in front of me.) At the outset I was aware of visualizing a telephone pole very near me at my right side; it was a typical Oregon second-growth fir pole, colored the light yellow-tan of fir wood with the bark just removed; this imagery extended only to my shoulders and loomed up vividly in front of a grey background. Together with this imagery I had very faint tactual imagery of a 'tingling' in the skin about my forehead and an incipient kinaesthetic process of drawing away from the image of the pole; all of this constituted an awareness that the pole was very near me. Next my attention turned to visual imagery of a paved street, in a light cement-like grey, which presented a smooth appearance unbroken or uninterrupted by street car lines or moving objects; at this juncture the street was empty; then I completed this visual image by seeing masses of forms, small and large, dark and light, passing by me in both directions and in two streams, the nearer one going to the left and the farther one to the right. Momentarily I shifted my visual attention from one of these moving streams of forms to the other and tended to follow each with eye-movement. Along with this visual imagery I had faint auditory imagery of wheels rumbling along the pavement and together with this dim roar—the only auditory imagery appearing in the entire process of imagination—the grey of the street became darker. The brightness and distribution of these forms constantly changed; many of the forms themselves were not visualized objects but visual synaesthetic images of the varied sounds which characterize street traffic; their constant shiftings in brightness and in position meant to me moving vehicles which were 'noisy.' Many of these fleeting visual symbols were too sketchy to describe but I singled out the visualized tooting of auto horns and the chugging of the motors by means of concentric rings of differently shaded grey lights and spasmodic puffs of whiter light. The visualized chugging of the motors was seen to issue from behind fleeting forms which latter meant the machines themselves. Concentric rings of shaded light, patterned something like the markings of a snake, stood for alternating weak and loud intensities of the chugging; the light portions indicated the explosions and the fainter portions stood for the intervals between the explosions. Then my visual attention shifted to the far side of the street where I momentarily saw high, shadowy forms looming skyward and together with this imagery I was aware of incipient motor tendencies in neck and eyes to look upward. By attending to these shadow forms I was able to distinguish large show windows dotted with color. Then I was aware of people behind me in terms of visual images of heels with halos of black around them; these halos were visualizations of the noise of footsteps. I could then build out, voluntarily, masculine and feminine voices, not in terms of auditory images but in terms of silvery ribbon-shaped visual forms for the feminine and darker, splotchy clouds for the masculine; these ribbon-shaped and cloud-shaped forms emanated from vaguely visualized mouths. The visualized sounds claimed my attention and I at no time tended to construct visual imagery of the persons themselves. During the entire pro-

cess I had no verbal imagery; I had no noticeable motor imagery other than what I have mentioned. (I have often observed that I can visualize objects directly behind my head without tendencies to move, or at least without noticeable tendencies.) Now, as I project objects behind my head, with attention centered upon an *Aufgabe* to notice any possible motor imagery, I am aware of slight tendencies toward eye-movement. I do not notice this movement, ordinarily. [Subsequent tests revealed the fact that in all shifts of visual attention there was either imagery of eye-movement or incipient eye tension. It will be noticed that *A* mentioned tactual imagery early in this introspection and reported no accompanying visual synaesthetic imagery. At times such an incident happens but upon reinstating this imagery or upon introspecting more carefully, it invariably turns out that *A* had visual imagery and that he was describing the tactual image by having recourse to the visual associate. Since the visual associate meant that the image was tactual, he called it a tactual image.]"

49. *Observer B.* Similar instructions. "I hardly know where to begin. There first appeared very real and intense tactual imagery of the cement walk beneath my feet; then followed auditory imagery, relatively not so real or intense as the tactual, of automobiles passing by, of wagons, street cars, horses and people all hurrying by me in blurred confusion of noice; I detected the rumble of people's voices, their footsteps, the rustling of their clothes. All of this imagery appeared and disappeared very rapidly with exceedingly swift shifts of attention from one detail to another. Then there appeared an awareness of a large building near me, consisting in part of a 'shadow feeling'—a vague, diffuse visual image of a shadow looming up at my side, together with very slight and incipient tendencies to draw myself together as if I were about to stop, hesitate, or shrink back. Then my attention shifted to a different group of processes consisting of incipient tensions about my neck and chest, tendencies in the region of the trunk and abdomen which I interpret as incipient contractions, a general muscular tendency to stand up straighter. All of this constituted a tendency to adopt a listening or expectant attitude as I imaged myself, kinaesthetic fashion, preparing to find my way across the street. Then appeared very shadowy and fleeting visual imagery of wagon wheels, of wagons and of automobiles turning around a corner toward me; this visual imagery had no setting of a visual sort; the wagon wheels were the only objects which approximated clearness and here I found, on closer introspection, that my visual image was two-thirds kinaesthetic and consisted of motor imagery of arm and shoulder as though my hand were following a certain point on the rim of the wheel during its revolutions. These experiences were followed by affective processes consisting of chest tensions, deeper breathing, motor imagery of unsteadiness—as if I were nervously keyed up and found it hard to tell in what direction I should proceed across the street. I then had tactual imagery of the sun's warmth upon my face; tactual imagery of holding a cane in my hand and kinaesthetic imagery of gripping the cane. During all this time my attention had been shifting suddenly from one detail to another, centering longer, however, on the motor imagery than upon any other type."

[Instructions: Imagine yourself taking a flight in an aeroplane. Report your imagery and other processes involved.]

50. *Observer A.* "To begin with I had very diffused kinaesthetic imagery of being in a sitting position and this imagery, under the instructions, meant sitting in an aeroplane; this was at once followed by the beginnings of a consciousness that I was in mid-air—an interpretation which, so far as I can tell, developed in the absence of no tendencies toward slight muscular teneseness about the face, shoulders and chest. (Whenever I am conscious of being near objects there exists this tenseness just referred to.) Then my attention shifted to a visualized roaring of the motor which consisted of a great mass of inky black rolls of smoke which seemed to cover an area in space about me the size of two city blocks. This 'smoke' obscured everything; it was dense

and thick, even rendering imperceptible my entoptic sensations; I was able to visualize nothing in or through this mass, neither was I able to obtain any auditory qualities of the roaring motor. I found it impossible to retain my present vantage point in my imagery, and visualize any objects beneath me or around me; I had to imagine myself situated off at one side or beneath this mass or imagine that the mass had been divided in two parts, leaving a 'cut' through which I could 'see' objects in the distance. I could not 'see' myself in the aeroplane and at the same time visualize anything else but the 'smoke,' for my visual attention was claimed by this blackness under these conditions—*i. e.*, so long as I was trying to imagine the sound of the motor. The instant I changed the *Aufgabe* from that of imaging the roaring motor to that of visualizing objects around or beneath me, the black 'smoke' disappeared; it simply melted away. I could not construct motor or tactual imagery of being hurled through space but I had a faint organic sensation of being lifted and dropped suddenly. (As I introspect I am able to obtain tactual imagery of wind pressing against my face and auditory imagery of the wind whistling by my ears but the mental content is entirely visual; I have no perceptible tactual and auditory qualities.)"

[Instructions: Imagine the world one million years ago and describe all the mental processes involved.]

51. *Observer A.* "I first had visual imagery of a European map built up from my anthropology and geology studies. In this visual imagery, which covered a large area spread out before me like a wall map, I saw at first only the boundary line between France and Germany; the rest of the map then cleared up and my visual attention suddenly shifted and I seemed to be in space just above a flat expanse of territory, rank with vegetation. This consisted of a rapid melting away of my visualized map before the developing visual image of a vast plane, colored a rich, deep green, and on which, here and there, I distinctly made out thickly growing fern stems and patches of palm leaves stretched out like fans. These latter were of a still darker green and were smooth and waxy in appearance. Then I had visual imagery of huge mastodons, in which only their huge bulks and general forms were definitely outlined; they were elephant-color. The scene suddenly changed to a 'close-up' view of one of these beasts; here I visualized the huge head with two long, curved, shiny, white tusks; narrow slits where the eyes belong, colored almost a black, and two flap shaped ears. I then constructed, in my visual imagery, fairly definite details about the joints of the forelegs. The imagery did not include definite details about the remaining portions of the animal; the remainder of my visual image of it merely included an undifferentiated mass of grey assuming the general shape of an elephant but larger. Then I had very fleeting visual imagery of a saber-toothed tiger—a fleeting cat-like form, streaked with color, slinking through the rank vegetative growth. This was followed by visual imagery of a primitive man, standing in a clearing before me; the clearing was suggested by the lightness of the green about him, compared to the dark forest background which had characterized my previous imagery. I saw this man naked, of stout, hairy body, with the hair especially black (blackness representing thickness) on his chest and on the front sides of his arms. On his chest there stood out very plainly little curly tufts in which I could make out individual hairs; in this visual imagery there also stood out the fact that the hair ran in different directions on different parts of the body, suggested by the shading in the blackness. Then I saw the man skulking about and trying to keep as closely under the cover of the forest as possible. The entire experience was rich in detail—the details standing out one after another as visual attention shifted from one feature in my imagery to another. There was no break in visual continuity and no tendency for visual imagery to shift or give way to imagery in any other modality. Was not conscious of vocal-motor imagery at any time during the experience."

52. *Observer B.* [Instructions same as for introspection 51.] "(I was intensely surprised to have fairly vivid visual imagery.) There first appeared rather lasting, clear and intense visual imagery of green trees, swaying in the wind. I saw them going on and on in the distance, indefinitely, tossing and tossing, one set of branches giving way to another as if I were passing them on a moving stage. (I suppose that this imagery was not as perfect or detailed as would have been the imagery of a sighted person, nor was it as stable.) This imagery lasted perhaps for a second but it seemed much longer, and then faded into kinaesthetic-tactual imagery of lying flat on my stomach and of reaching my arms out over a sea of space and what was my visualized field of branches but an instant before; very vivid and intense was the imagery of upper arm and shoulder as I imaged myself swinging my arms and together with this there appeared almost equally as intense imagery, with incipient movements, of taking long deep breaths. All of this called up vocal-motor imagery of such words as 'gigantic', 'sweeping', 'forest', 'primeval', 'terrible vastness', 'massive' and the like. Then I was aware of kinaesthetic imagery of making large sweeping arcs with my arm, as if I were pointing out to some one a vast expansive territory. There then followed tactual imagery of thick grass about my feet and of grass twining around my ankles."

[Instructions: Imagine yourself walking a tight-rope.]

53. *Observer* A. "At first I could get very complicated kinaesthetic imagery, together with visual imagery of the rope stretched beneath my feet and visual imagery of my feet upon the rope. The ends of the rope were not visible nor were the objects to which the rope was attached. The motor imagery consisted first of swaying my legs rapidly to and fro sidewise as the rope swayed in that fashion; for a moment this imagery was localized very distinctly in my knees and calves; then this motor imagery expanded to include shoulders, back and arms, as I seemed to be swaying my body in an effort to keep my balance. This series of motor images was continuous both kinaesthetically and visually; I could attend momentarily to the kinaesthetic qualities of motion but the instant my kinaesthetic attention began to shift from one motor image to the next, the preceding image, then 'tapering off' in attention, had turned into a visual image of a black area localized where the motor imagery had been localized and formed into a moving streak or ribbon, representing the extent and direction of the motor imagery itself. If I tried to hold this disappearing motor image in consciousness I inevitably found that it had vanished and that I was attending to a visual synaesthetic image of the movement instead." [From this introspection it would seem that kinaesthetic imagery shifts to visual less suddenly than does imagery in *A's* other non-visual modalities. It is interesting to note that kinaesthetic imagery may tend to occupy focal attention so long as *A* makes no voluntary effort to hold it there, and that the kinaesthetic process may not become visual until it has nearly run its course in consciousness. It does become visual, however, before it entirely fades from non-focal consciousness.]

ii. Summary of introspective data on processes of imagination.

Observer A. *A's* imaginative processes are dominantly visual and this visual imagery is of two sorts: (1) visualizations of objects, scenes, etc., and (2) synaesthetic imagery which appears either with or without the primary imagery whose qualities and behavior it "takes over." Kinaesthetic imagery appears next in order of frequency, followed by tactual and then auditory. All of these non-visual "images" tend to shift at once into their visual accompaniments, the kinaesthetic type being delayed in this shift, at times, with the result that it seems to occupy consciousness momentarily, almost by itself. Auditory imagery is practically confined to the auditory accompaniments of verbal imagery, and here the motor factor is much stronger than the auditory; both tend at once to change into visual associates. Of interest is the rareness with which tactual imagery appears in *A's* imaginative processes, and its confinement largely to tactual-kinaesthetic-visual complexes.

We find, as in our previous series of experiments, that *A's* visual images are relatively much richer in details of hue and brightness than in details of shape and outline. Accordingly, *A* pronounces his imagery rich in detail if in its general shape and form it is relatively persistent, or if his visual attention shifts, undisturbed, from one rather vaguely outlined object or region in his imagery to another. Indefiniteness of minute detail and indistinctness of outline may possibly be due to *A's* 17 years of blindness. In visualizing the traffic of a city street, *A* sees but passing shapes and forms for wagons, horses, automobiles and the like; in visualizing an office building, dots and patches of color represent objects on display in the show-windows; details of construction such as small bricks, large stone blocks and the like do not appear unless under a special *Aufgabe* to construct them voluntarily. The rank tropical vegetation of a jungle is represented by darkness, ''thickness'' or richness of the green color in the imagery and by glimpses of massed fern stems, clusters of ''waxy'' green fan-shaped palm leaves and the like. Details are otherwise lacking.

Structurally *A's* visual imagery may not differ from the same type of imagery in a poor visualizer, but functionally *A's* visual imagery is more important to him than is similar imagery in a sighted person who is asynaesthetic. The poor visualizer, as for example our other blind reagent, has a wealth of other imagery which compensates for a dearth of visual detail. Whenever and wherever visual imagery appears in *A's* consciousness, it occupies the focus of attention no matter how vague or imperfect that imagery may be. The poor visualizer's attention may be centered and usually is centered upon details of other types of imagery with the result that visual imagery itself seldom occupies the focus of attention.

A's introspections on his imaginative processes confirm our previous findings with respect to the functioning of synaesthetic processes; for not only do non-visual images always merge into the same stereotyped visual associates as appear in corresponding processes of perceiving, but these visual associates, now detached from their parent processes, symbolize original sensory experiences from the non-visual modalities. For example, feminine and masculine voices were represented by silvery, ribbon-shaped streaks of color and dark grey, splotchy clouds respectively. The chugging of an automobile motor, the tooting of horns, the roaring of an aeroplane motor were likewise represented by variously colored and shaped visual synaesthetic images. Tactual imagery of a cold wave dashing over the body, and difference in pressure against the balls of the feet in walking over rough ground were present in consciousness wholly in visual terms. In none of these instances were any non-visual qualities present to consciousness. The hue, brightness, shape, size, and behavior of the visual images represented the non-visual qualities and the behavior of the missing non-visual elements.

Observer B. Kinaesthetic imagery dominates in *B's* imaginative processes, followed by auditory and then tactual. Visual imagery is the least frequent and seems to appear more or less as a surprise to the reagent. The same features characterize these different types of images as were found in our previous experiments. Organic processes frequently accompany *B's* imaginations and are for the most part incipient innervations of muscular movement rather than imagery. In fact the reality and vividness of organic and kinaesthetic processes is throughout *B's* consciousness correlated directly with the extent of incipient motor responses.

iii. Observers A and B compared.

B is more imaginative in his everyday mental life than is *A* and consistent with this fact we find that *B's* imagery in processes of imagination are richer in detail, faster in appearance and disappearance and subject to longer and more complex groupings and successions.

As in previous experiments we find that *B's* attention is dominantly kinaesthetic while *A's* is dominantly visual. But again we find no parallel contents in *B's* mental life similar in function to *A's* synaesthetic phenomena. For example, if *B* has kinaesthetic imagery of a circle, this kinaesthetic imagery is not a symbol for a visualized circle; one form of kinaesthetic imagery does not represent a white circle on a black background and another form of kinaesthetic imagery does not stand for a black circle on a white background. That is, there are no properties of this motor imagery which stand for former visual experiences. *A's* visual imagery represents specific qualities and modes of behavior of non-visual processes. Thus *B's* kinaesthetic backgrounds and *A's* visual backgrounds function in different fashions; the former supplement and indirectly render more definite such processes as appear in non-kinaesthetic modalities while the latter directly define and take the place of such processes as tend to appear in non-visual modalities.

Furthermore, while *B's* kinaesthetic images have possibly come to take the place of decayed visual functions, the former do not stand for or directly define the latter. *A's* visual synaesthetic images function more than in the capacity of visualizations of objects; they function further than as a mere substitution for decayed modalities.

iv. Significance of A's synaesthetic phenomena in processes of imagination.

Aside from confirming our previous findings with respect to *A's* synaesthetic phenomena, a study of his imaginative processes reveals added significant facts concerning the rôle which these phenomena play in consciousness. First, it is to be noted that organic and kinaesthetic imagery is slightly delayed, at times, compared with imagery from other non-visual modalities, in the process of shifting to its visual accompaniment. Although we had found some evidence of this in our earlier experiments the relatively greater frequency of organic and kinaesthetic factors in *A's* imaginative consciousness than in types of consciousness studied in our previous series has brought this difference into the foreground. This delay in the tendency for organic and kinaesthetic images to shift into visual processes means that they approach in their original form nearer to the focus of attention than do other non-visual images. As a result *A* is able to ascribe to them more definite attributes of their own. These facts suggest that a kinaesthetic process is so important, as such, in mental life, that no non-kinaesthetic process can function as an adequate symbol for it. It seems safe to conclude, therefore, that in *A's* case we find no exception to the general rule that kinaesthetic processes are essential constituents of mental life. In *A's* case there are imaginative situations, particularly those which involve bodily movement or adjustment, bodily attitudes or motor attitudes as they are more often called, which are more or less implicitly capable of functioning in the development of meaning. At least they are sufficiently capable of so functioning that their transition into subsequent and definitizing visual processes is delayed.

We are inclined to regard this exception to *A's* synaesthetic functioning as not only one which was to be expected but one which throws added light upon the nature of synaesthesia itself and also upon the real value of consciousness. If we assume that the function of consciousness is that of evoking bodily movements—explicit behavior—we should expect that motor imagery itself, because of the fact that it is direct imagery *of movement,* should most readily of all imagery arouse movement and particularly that movement which the motor image anticipates. On the other hand one would expect that visual, auditory and tactual imagery might all lead to movement with approximately equal readiness. Thus, in *A's* case the visual concomitants of auditory and tactual processes would function quite as efficiently in controlling co-ordinated explicit behavior as might the auditory or tactual processes themselves. As a matter of fact we have seen that in his case the latter function in consciousness more readily than do the former. Hence it may be that his visual functions have a closer connection with bodily movement and hence function more readily in consciousness because they more readily lead to overt response than do the non-visual processes for which the visual images stand. We might assume by way of explaining this situation physiologically, that visual functions are more closely integrated with the motor projection areas of the brain than are his non-visual functions.

Furthermore, since kinaesthetic imagery is apparently more closely connected with efferent projection centers than any other type of imagery—witness the frequency with which kinaesthetic imagery is accompanied by or with which it leads to incipient innervations—even *A's* synaesthetic visual images do not always take the place of kinaesthetic qualities, in consciousness. All the more plausible becomes this view when we notice that kinaesthetic imagery is delayed in shifting to its visual accompaniment only when it is definitely followed by incipient movement.

D. Series 4. Free associations.

i. Typical introspective data.

[Instructions: I am going to present to you a word in auditory fashion to which I want you to respond orally with the first word which enters your mind. Ready. Now.]

58. *Observer B.* "While the experimenter was reading the instructions I was focally aware of his voice, together with increasing tendencies to sit more erect in my chair, to contract about the chest, shoulders, face and throat. There was also a slight tendency to hold my breath. The whole process thus far consisted of an attitude of alertness in which my attention was centered, in auditory fashion, upon the experimenter's voice. This latter fixation of attention consisted of tendencies to lean in the direction of the experimenter and to become conscious of faint sounds in the region of my right ear which was nearest the experimenter. Then I perceived the word 'whistle.' For an instant this dominated attention and the quality, enunciation and other details of the auditory perception stood out focally in consciousness, one following the other; just at this juncture I noticed a general tendency toward muscular contraction in the region of the abdomen and chest as if I were inhibiting my breathing, together with marked tensions in the back of my throat; these latter developed into incipient tendencies to assume a mouth and throat position as if to whistle and were accompanied by very faint and sketchy auditory-vocal-motor imagery of the word 'whistle.' Just as my attention was lingering upon these developing tensions I found myself beginning to innervate a word, the movements of which seemed to be derived from the positions of my lips previously taken in assuming a mouth position to blow. I then found myself saying 'blow' out loud. I was not aware of the word as such before I said it; neither was I conscious of any antecedent imagery which might have suggested it other than what I have described."

59. *Observer A.* Similar instructions. Word: whistle. Response: boy. "* * * As I heard the word 'whistle' I found my attention at once leaving the quality of the experimenter's voice and shifting to a visual image of a white, cloud-like form about the size and shape of a pillow case, with the visual quality a linen-white. This image was localized in space in front of me at a distance of about six feet. The right edge of this form—toward the experimenter—was much brighter than the rest and glowed as the reflected light from a white crystal might glow; (this I discovered was due to the 'sss' sound from the word 'whistle'.) This visual image persisted but at once began to drift upward and to the right. My attention was momentarily absorbed in wondering what caused this colored form; I then became conscious of the task in terms of a developing strained condition in my throat and in a tendency to repeat the word 'whistle' in terms of auditory-vocal-motor imagery of my own voice; but this latter imagery had but just begun to develop when my attention was claimed visually by an image of a boy with only head and shoulders showing and with no detail of eyes or other facial features. The general size and shape of the image indicated that it represented a boy rather than a man or woman. All during this time the synaesthetic image mentioned above was persisting non-focally in consciousness and was drifting off into the upper left hand field of vision. Upon the appearance of the boy in visual imagery I found myself tending to relax about the abdomen and shoulders as if the task were over, but the strain in my throat became greater and I found my attention shifting from my visual image to my throat region which was subsequently visualized in black. Then I first became aware of the fact that I was trying to say something and couldn't. After a period of brief delay I found myself saying, suddenly, 'boy' and along with this vocalization there appeared a dark grey, almost inky smudge in the center of my field of vision, entirely obliterating my visual image of the boy. This smudge was the stere-

otyped visual counterpart of the word 'boy' and is determined largely by the letter 'b'. (For a moment during the reaction I was satisfied that my visual image of a boy was my response to the stimulus word.)"

60. *Observer B.* Instructions the same as before. Word: become. Response: becoming. Reaction time, 3 and 3-5 seconds. "On hearing the word 'become' I had some auditory imagery which I have entirely forgotten owing, presumably, to the intensity of my efforts to find a stimulus word. Following this auditory imagery my attention was claimed by rapidly developing and long persisting tensions localized about my abdomen and chest, by undifferentiated organic reactions which I think involved respiratory and circulatory changes, all of which constituted a feeling of ghastness. This long and drawn-out motor reaction was followed by a spontaneous vocalization of the word 'gee!' Then I was aware of faint and syncopated auditory imagery of professor R. talking about 'becoming', but the word 'becoming' itself stood out no more clearly than did any of the other auditory imagery. Following this was a short period of utter blankness of mind so far as imagery was concerned, characterized by a lingering attention upon my motor tenseness. Then auditory imagery of the stimulus word appeared and persisted for some little time, then for only the briefest instant of time my attention shifted to auditory imagery of professor R's voice again and this was immediately followed by sudden vocalization of the word 'becoming'."

61. *Observer A.* Similar instructions. Word: become. Response: three. "As I heard the word 'become' I found my attention at once shifting from the sound of the word to a peculiarly shaped visual image like that of a letter 'B' lying on its belly. The left half of this image was dark grey; the right half was the color of bee's-wax. This whole image drifted off from my field of vision and I found my attention momentarily occupied with the entoptic phenomena which were left. I then reinstated the visual image just described and at this juncture I was first aware of the meaning of 'become'; up to this time I had not grasped the meaning of the word. I could not have told you what the stimulus word was until after this visual associate appeared the second time (having been 'yanked back' into consciousness by eye-movement); it seemed to me as if I were re-attending to the stimulus word itself, although there was no auditory or vocal-motor imagery present to consciousness. With no warning this visual image shifted its position, turning up upon one end, and the bee's wax turned into a deeper reddish-buff; my attention was automatically claimed by this new color; with no further intervening processes this color meant 'three' to me; I tended to have the word 'three' in vocal-motor imagery and together with this fleeting verbal image the color became more saturated and more definite in shape. I then found myself responding orally with the word 'three'." [This shows how in *A's* mental life one visual associate will suggest another, just as in ordinary consciousness one image suggests another. *A's* processes of association in this experiment took place entirely within the visual modality.]

62. *Observer A.* Similar instructions, with the added *Aufgabe* to watch for processes other than visual, if any. The stimulus word was 'genus'. Response: man. "While waiting for the stimulus word to be given my attention was fixed upon my throat and I was aware in tactual-kinaesthetic-visual terms of localized strains in my throat muscles. Upon hearing the stimulus word there appeared a bright area about like sunlight in the center of my field of vision; this image claimed focal attention to the exclusion of any consciousness of kinaesthetic or other processes. The white light came from the 'ge' sound in genus. I then became aware of the instructions and immediately found myself again visualizing my throat and trying to attend to the kinaesthetic and tactual processes from throat position and strain. Thereupon the whitish

light disappeared and with this disappearance of my visual image I found that I had lost consciousness of the stimulus word. By this time I became conscious of keeping the experimenter waiting too long for my response, consisting of tendencies to visualize the experimenter. As a result of this my awareness of my throat also tapered off suddenly into obscurity. My response 'man' came evidently as a direct association with my visual image of the experimenter, for immediately following this image of him I found myself vocalizing the word 'man'. With this vocalization there appeared the yellowish synaesthesia of the word 'man'."

63. *Observer B.* Instructions as before for observer *B.* Stimulus word: after. Response: before. "Following the perception of the experimenter's voice I was aware of very vivid and intense auditory imagery of the stimulus word, then of a schematic kinaesthetic image of my own throat and lips assuming a position to repeat the word. There followed a moment of hesitation in which my attention was centered upon the strained condition in my throat. Then, with no antecedent process or no warning, I found myself repeating in vocal-motor-auditory imagery the word 'before' and vocalized it at once."

64. *Observer A.* Instructions as before for observer *A.* Stimulus word: after. Response: brown. "There first appeared, together with my auditory perception of the stimulus word, a shapeless cloud of calf-brown color. My attention went at once focally to this color. At no time was I focally conscious of the auditory qualities of the word or of the experimenter's voice. For an instant I paused, during which time attention shifted, non-focally, to the region of my throat and I had the vocal-motor image: 'What is it?' referring to the calf-brown color which was aroused by the stimulus word. As if in answer to this question, I found my attention lingering upon this brown visual image and myself saying the word 'brown' in vocal-motor imagery. The brown was due to the 'ft' sound in the word 'after'. At no time during the experiment was I aware of the meaning of the full word. I was aware, however, that the brown meant 'ft' sound."

65. *Observer A.* Similar instructions. Word: nerve. Response: 'ous'. "Just as the word was perceived, a light yellow patch of color appeared, slightly pear-shaped but relatively longer at the small end than a pear. The left portion of the color-patch represented the 'ner' of 'nerve.' But the experimenter had no sooner finished saying the word when this color patch extended along the neck of the narrower portion and there became a much brighter yellow and I found that, at the same time, I was having auditory-vocal-motor imagery of 'ous'. The bright yellow is the synaesthetic associate for 'ous' sound. This brilliant yellow, together with the vocal-motor image of 'ous' persisted so long in focal attention that I found my vocal chords 'tied up'; I could think of nothing else. I therefore reported that I could not think of anything else and that my response was but a completion of 'nerve' into 'nervous'. (This is the fashion by which I always anticipate what a person is going to say next when I am listening to a lecturer or when I am taking part in a conversation. I anticipate the speaker's words in terms of color, with no clear consciousness of any vocal-motor imagery at all.)"

ii. Summary of introspective data on free association.

Observer A. The perception of the stimulus word invariably involves a stereotyped visual associate whose color or brightness is determined by the dominant sound of the stimulus word itself. This observer never focally "hears" the experimenter's voice nor is he focally conscious of auditory qualities in his own verbal imagery of the stimulus word. The latter imagery demands a similar visual associate before it is complete. After the original visual associate appears in consciousness *A's* attention is directed to its behavior. If the image develops into no further processes either verbal or visual but begins to fade away or drift off to one corner of his visual field, trains of association are momentarily halted and *A* finds his attention claimed either by visual entoptic phenomena or by a strained condition in the throat. Under these conditions the throat strains may develop into an *Aufgabe* consciousness and hence to a recall of the stimulus word in vocal-motor terms. Thereupon the original visual synaesthetic image reappears. From here on in the course of free association the response develops invariably in terms of visual imagery. Perhaps the original synaesthetic image may change its shape or color; the product of such a change in the visual image represents a response word which the reagent immediately attempts to translate into verbal imagery. At times this translation process is delayed and as a result the reagent finds himself trying to pronounce a word which he cannot say. His attention is then claimed by visualized throat strains. The response is complete when the reagent has succeeded in translating the final color into its appropriate verbal image. It might be interpreted as being complete so far as the reagent's own consciousness is concerned when he has become aware of the meaning of this final color. Sometimes a verbal image identifies the color; sometimes an antecedent visual or verbal image has sufficed to give enough meaning to the final color to cause *A* to relax as if the response were complete; and sometimes the reaction terminates in a motor response which means familiarity so far as the reagent himself is concerned.

Peculiar response words result from the functioning of his synaesthetic images. ''Three'' was his response to ''become,'' a totally irrelevant reaction from the point of view of an asynaesthetic person; but the ''three'' was suggested by the shape and color of the original synaesthetic image which accompanied the auditory perception of ''become.'' The ''be'' sound of ''become'' has the same color as the ''ee'' sound in ''three.'' Again, ''brown'' was his response to ''after.'' This was determined by the calf-brown color which was aroused by the stimulus word.

Observer B. B's procedure in forming free associations is entirely different, as far as its content is concerned. He is first focally aware of the stimulus word; the quality of the experimenter's voice or the articulation of the word momentarily stands out with marked clearness. Then he has auditory-vocal-motor imagery of his own voice repeating the stimulus word or he is aware of auditory imagery of the experimenter's voice. Then there may occur a brief pause during which time *B's* attention shifts to kinaesthetic or tactual processes having to do with a strained throat condition or with more or less reflex incipient movements about the lips, tongue or throat. The response word may first appear in vocal-motor imagery, followed by innervation, or it may appear at once as an innervated vocalization. It is always suggested by some tactual or kinaesthetic antecedent process, such as a peculiar tendency to assume a mouth-position as if to blow, or such as a series of vocal-motor imagery having to do with memories of a lecture in philosophy. The mental processes in *B's* case are thus confined to kinaesthetic, auditory, tactual and perhaps organic sensations and images.

iii. Free association in A and B compared.

1. In the perception of the stimulus word *B's* attention is focused upon the auditory qualities of the spoken word. *A's* attention ignores the auditory qualities and shifts at once to a stereotyped visual concomitant.

2. In *B's* consciousness the auditory perception is followed by auditory or by vocal-motor imagery. In *A's* consciousness the visual associate of the auditory perception persists as a substitute for auditory or vocal-motor imagery.

3. *B's* attention is then directed implicitly toward the act of finding a response word; this act involves such processes as kinaesthetic sensations, verbal or auditory imagery or tactual imagery. *A's* attention is implicitly directed in similar fashion but the contents of consciousness remain dominantly visual and visually synaesthetic in their nature. While *B's* attention is shifting among kinaesthetic, auditory, and perhaps tactual processes, *A's* attention is shifting among changes in his visual synaesthetic imagery—from the original synaesthetic accompaniment of the auditory perception to a detached visual associate, representing an additional non-visual process.

4. The final cues for *B's* responses are kinaesthetic, tactual or auditory. *A's* response is a persistence of a visual image which

stands for an auditory, vocal-motor, or kinaesthetic process. At times vocal-motor imagery supplements the visual but the former is not attended-to focally.

5. Thus in free associations the functioning of mental processes is the same in both reagents, *i. e.*, both reagents are behaving in essentially the same fashion; but the mental contents differ radically in our two observers.

iv. The significance of synaesthetic phenomena in A's free associations.

A mass of introspective data on *A's* free associations brings out more clearly than in our previous series of experiments just how synaesthetic phenomena function in the development of meaning. We have seen that a stereotyped visual associate is involved in his perception of the stimulus word. If this visual image does not at once lead to further visual imagery or to some subsequent verbal process *A fails* to understand the meaning of the stimulus word. Such a subsequent process may consist of a tendency to vocalize the word in which case the original synaesthetic image is definitized, clarified, or modified so that it at once leads to a further process. *Meaning* is thus found in the *process-aspect* of experience and not in the content-aspect. For example, if in *A's* case a visual associate of the stimulus word fails to lead to some other visual image or to some other process, no meaning develops; but if the visual image leads or shifts to some other visual image or to some other subsequent process the experience has meaning. Mental contents are therefore only the tools, the mode or the method by which meaningful processes take place; the activity or process-aspect—the behavior of these contents—is the criterion of meaning. It is certain also that a combination or mosaic of contents must be in action before meaning can develop; such a group, of itself, does not provide meaning. For example, a complex visual synaesthetic image may appear in *A's* consciousness; such an image may virtually be a group of contents for the reason that in it are involved shape, various hues, size and what not. But if such a complex fails to *change* in some way, to shift, or to lead to something further in consciousness, the experience is meaningless. Detached mental contents are thus devoid of meaning. Ordinarily such colors mean something to our observer; they mean an object, a word, a letter; they constitute an idea or what not. But they so constitute a meaningful experience only when they appear in a succession of flowing, *changing* mental contents. To illustrate: *A* once reported in the above experiments visual imagery of a small patch, dark steel grey on one side, shading into brilliant white on the other. This image partly disappeared, leaving behind it an isolated patch of white. Up to this time the synaesthetic image had meant the stimulus word "honest" for the reason that it had developed in succession with an auditory perception of the stimulus word and with a non-focal verbal image. But as long as this white patch lingered alone in consciousness without changing, *i. e.*, without leading to some further process, it continued to possess no meaning. On the other hand no visual synaesthetic image which happens to lead to some further process is devoid of meaning.

The reader has undoubtedly asked himself how it is possible that mere colors and brightnesses can mean so many things in *A's* mental life. If meaning consists of the behavior of mental contents, *A's* case is readily explained. In no sense modality are there so many different qualities as in the visual; in no sense modality can shifts from one quality to another, from one shape, form or size to another take place so rapidly or so easily as in the visual. Moreover, in no sense field is it possible to have as many different qualities simultaneously present to consciousness and thus simultaneously leading to further processes as in the field of vision. Thus we might expect that visual imagery may function most adequately of all the modalities as contents which provide meaning when they change or shift. The asynaesthetic person would find it either impossible or very difficult to cultivate his visual imagery to the extent that it will function as adequately as *A's* in this respect for the reason that such extended voluntary control of visual imagery as is possessed by *A* comes only with synaesthetic functions. *A* cannot help but employ visual imagery constantly in the development of meaning for the reason that this imagery is constantly present in his consciousness.

Our results on *A's* free associations also reveal added evidence that the functional significance of synaesthesis extends beyond the realm of perceiving. Here not only does the visual concomitant of the stimulus word "convey" the meaning of the word itself, thus leading to further associations, but verbal recalls of the stimulus word usher back into consciousness this same visual concomitant; the success of the final response depends upon the behavior of this visual concomitant; subsequent verbal images of other words invariably possess their own visual associates; and finally, detached visual associates appear in response to or are suggested by antecedent synaesthetic images and they frequently appear minus their verbal counterparts; such detached visual associates which stand for response words function quite as well in the response itself as any verbal or kinaesthetic tendency in the asynaesthetic individual might function. For example, *A* at times finds himself relaxing, as if the response were over, when a final detached visual associate appears in consciousness as a substitute for a vocal-motor image. Subsequent throat tensions on *A's* part simply mean that he has not translated this detached visual associate into its corresponding verbal image for the experimenter's benefit. Further evidence that synaesthetic images are just as important in the realm of thinking as they are in the realm of perceiving might be given at length.

More striking than these facts, however, is the effect which these visual processes exert upon *A's* own interpretations of his experiencse immediately after they have taken place. Not infrequently, when *A* had recalled a detached visual associate of the stimulus word, did it seem to him that he were recalling auditory imagery of the experimenter's voice, although no auditory qualities as such were present to consciousness. So intimately bound up with sounds are colors in *A's* mental life that they are actually interpreted to be sounds. The same is true of pressure and other sensory experiences. But all of this may take place in the absence of peripheral stimulation. One can hardly ask for more definite evidence that synaesthetic phenomena should be regarded as true synaesthesis.

V. A THEORY OF SYNAESTHESIA

The whole problem of synaesthesia needs working over in the light of more detailed and exhaustive laboratory experimentation. Too often has it been regarded an anomaly which aroused interest only from the point of view of curiosity. We have pointed out that introspective descriptions of such phenomena have been lacking in the literature; that no investigator has demonstrated that synaesthesis is confined, in any one case, to the field of perception; and that only a very small percentage of contributions to the problem have mentioned the existence of extra-perceptual forms. Moreover, it is more or less remarkable that so few investigators have observed the apparent connection between synaesthesis and the general problem of meaning.

From a detailed study of only one case it will be impossible for us to derive conclusions which claim general validity. Neither will it be possible to confirm or destructively criticize much of the work which has already been done on synaesthesia. Our results have been obtained and have been interpreted solely from the point of view of the value or function of synaesthetic processes in the consciousness of our subject who possesses it. Nevertheless we feel justified in discussing certain alleged facts and certain theories which have appeared in the literature inasmuch as one case, thoroughly studied, ought certainly to prove suggestive.

As early as 1864 Chabalier (3) very nearly reached the core of the functional problem when he noted that letters were meaningless without their colored associates. One of the Nussbaumer cases of 1873 (8) throws some light upon the problem. It was noticed that isolated tones were always colored for the same individual, while musical concerts were not. This fact points to a cognitive theory of synaesthesis rather than to a physiological theory as such. For if synaesthesis is due to changes in blood supply in the brain—to the physiological disturbances underlying emotional states of mind—one would certainly expect that if colors were to appear in the one situation (isolated tones) and not in the other (listening to a concert) the concert would produce the colors. Any physiological view such as that of anastomosis of fibers or a lack of differentiation of function in adjacent brain areas would lead to an inevitable ''seeing'' of colors when tones were heard. If such theories were true one would hardly expect that in the same individual synaesthetic processes would appear one moment and not the next. But if synaesthesis is a cognitive process and purely functional in nature, rather than a phenomenon based upon structural-organic brain conditions, *i. e.,* if it is definitely a problem of meaning, then we can understand how a person could experience colored tones without colored concerts. Combinations of tones, successions of tones and harmony possess different meanings from isolated tones. Thus while perceptions of isolated tones might, in a certain individual, require synaesthetic imagery, the understanding of a concert—an entirely different cognitive process—might not of necessity involve colored hearing. In a succession of tones a subsequent tone may interpret its antecedent while an isolated tone has no such subsequent tone upon which its meaning can be based.

In 1887 Steinbrügge (91) hinted at the evident nature of synaesthesis when he suggested that it was a ''double-perception,'' or a primary perception accompanied by a ''sub-perception.'' But he concluded that the visual synaesthetic image appeared too rapidly upon the sound stimulus to allow for the forming of an association between a sound and a visual image. Therefore he resorted to a purely physiological theory. In 1913 (2) Bleuler criticized the association theories of synaesthesia on the ground that colors may be connected with sounds in colored hearing as early in childhood as to precede the development of meaning. While no one knows exactly when meaning develops in the life of a child the assumption does not seem wild that imagery and meaning develop hand in hand. We know that synaesthesia has come to function as meaning in the mental life of our reagent; we know that it functioned as meaning as far back as he can remember. As long as synaesthesis persists we should expect it to function as a process of meaning; when synaesthesis disappears as it is said to do in certain cases, the particular meaning constituted by the synaesthetic process has likewise disappeared. Meanings are absolute whether they be specific or general. Meanings disappear with process-functions; new process-functions provide new but perhaps similar meanings.

The observed permanence of synaesthesis (see Holden, 4, Jordan, 5, and Wheeler, 11) points to permanence of meaning. For example a certain child might come to have a visual image of blue with the letter ''e''; as long as this synaesthetic image persisted in the individual's mental life this same blue would always mean ''e''; but if the blue should disappear in connection with the ''e'', some other processes would take the place of the visual synaesthetic image such as auditory, vocal-motor or some other, and asynaesthetic visual image.

The stereotyped nature of the synaesthetic image offers no particular difficulty when interpreted as a meaning-phenomenon. Meanings are always stereotyped. This absolute nature of meaning provides validity to knowledge itself. But it is the manner of functioning of mental contents, rather than specific mental structures as such, which gives to meaning its absolute character. Thus if synaesthesis is a meaning-function we should here expect to find stereotyped meaning as well as structure and this is what we actually do find. The important issue, then, is not concerned with the fixed structure of the synaesthetic image but it is concerned with the manner in which one particular image rather than another happened to develop as the partner to the primary process in the growth of meaning. The problem in colored hearing is then: Why does a certain blue or yellow rather than an auditory or a vocal-motor image come to identify the sound of a tuning-fork; or why does the shift of attention from non-focal auditory qualities to a visualized color function as meaning rather than a shift from auditory qualities to other visual or to vocal-motor tendencies? In either case the shift of attention—the functional aspect—is the stereotyped factor and the problem lies in explaining why one subsequent process rather than another came to be selected as the identifier of the tuning-fork sound.

Hence our notion as to a plausible theory of synaesthesis has changed as a result of our present investigation. We do not argue that meaning is a cause of synaesthesis or that synaesthesis is a cause of meaning; nor will we admit that the two are accompaniments of one another for reasons which we will discuss later. We hold that synaesthesis *is* meaning; that it is a process of meaning. Thus we can no longer accept a theory of anastomosis or of entanglement of fibers for the reason, first, that such a brain condition would lead to a permanency of synaesthesis. Some forms of synaesthesis are not permanent. If fibers became entangled or anastomosed during growth we should expect them to always remain in that condition. Secondly, this view can hardly describe the situation with respect to synaesthetic phenomena in the higher intellectual processes where every other modality is paired with a visual image, and where association is reversible. Neither would it explain how colored tones can exist without colored concerts. Thirdly, it presumes that synaesthesis is only a perceptual process, taking place with peripheral stimulation. And such, we have found, is not the case.

Furthermore we have been obliged to discard lack of differentiation of function as a possible theory. If brain areas are lacking in differentiation of function, thus causing a confusion between audition and vision, or causing a dual response from a single stimulus, we would have to conclude that in certain cases every localized sensory area *except* the visual lacked differentiation—a highly improbable state of affairs. Moreover, this view would lead every isolated tone and combination of tones to appear colored in colored hearing. This is not always the case. Again, since every attribute of a sound sensation or an auditory image, in our subject at least, has its concomitant in an attribute of the visual associate and determines this corresponding attribute in the visual associate, there must be as great a differentiation of function in the auditory as in the visual center of the brain, otherwise these detailed causal relations between the auditory and the visual processes could not exist. The auditory area, lacking differentiation, could not operate in causing differentiated functions in the visual area. And finally, neither of the two views just mentioned gives us any clue as to how a dissociated or detached visual synaesthetic image comes to stand for or mean an auditory process. In fact all of the physiological theories which have so far been advanced fail to take into consideration the cognitive functions of synaesthesis.

The facts which have been construed as pointing to a physiological theory are as follows: (1) the simultaneity of primary and secondary process in synaesthesis; (2) the close proximity of brain areas involved in synaesthesis; (3) the stimulating influence of drugs; (4) the irreversibility of (perceptual) synaesthesis; (5) the influence of fatigue; (6) the disappearance of synaesthesis during adolescence; (7) the dependence of secondary attributes upon primary attributes; (8) the early appearance of synaesthesis in childhood; (9) the suddenness and spontaneity with which any single instance of synaesthetic association arises. These arguments are either misleading, or, as we have already pointed out, their truth is open to very serious question. Rather than pointing to a physiological theory, these arguments all point to the cognitive nature and functioning of synaesthesis and to theories of reflex mechanisms. They do not necessarily point to organic conditions.

Meaning involves simultaneous groupings of contents and process-functions. The brain areas involved in synaesthesis may be as far apart as brain anatomy will allow. Meanings are influenced, just as synaesthesis is influenced, by drugs. Meanings change during adolescence. Meanings are determined by attributes of sensory experience and so are synaesthetic images. Meanings obviously develop with the growth of imagery in childhood. Meanings develop ''suddenly and spontaneously'' in the same fashion as does synaesthesis. Who has not tried to comprehend the meaning of something and has not found that meaning ''dawning'' upon him suddenly and with evident spontaneity?

The ''meaning''-interpretation of synaesthesis allows for perfect harmony between the facts which were alleged to have supported a physiological view and the facts which have been advanced in support of an association theory. (See 11, page 38, for arguments in favor of an association theory.) Otherwise we cannot harmonize the two sets of facts without positing two radically different species of synaesthesis, an assumption entirely unwarranted by the facts. If one reviews the facts concerning synaesthesis he finds everything in favor of the phenomenon as a meaning-function and nothing against it. Such facts in part are: the variability in localization of the secondary process; the intensifying effect of emotional experiences; the fact that no two people have the same association in synaesthesia except as a matter of coincidence; the fact that in some cases visual perceptions arouse synaesthetic visual imagery, and the like. In addition to these facts we are confronted by the following results from this investigation: (1) meaning is lacking in the absence of the synaesthetic image; (2) the synaesthetic image invariably identifies the primary process in every particular and in general as well; (3) wherever several primary processes have the same meaning they are identified by the same, single secondary process (for example, a flute tone is yellow, auditory imagery of that flute tone is yellow, the word ''flute'' suggests the same yellow, etc.); (4) the secondary process functions for familiarity; (5) the synaesthetic image may control the direction of the reagent's trend of thought; (6) the behavior of attention in perceiving and in recognizing is the same in our synaesthetic reagent as it is in the check reagent wherever meaning develops; (7) the synaesthetic image functions in an *Aufgabe* consciousness as do other meaningful processes; (8) under conditions which do not allow for the development of meaning, synaesthetic images are meaningless; (9) synaesthetic phenomena function in the development of meaning as marginal or ''background'' processes of consciousness in the same fashion as does a kinaesthetic background in the asynaesthetic reagent; (10) synaesthesis is reversible wherever meaning is reversible and is irreversible where meaning is irreversible; (11) synaesthetic processes function in the foreshortening of meaning contexts.

We believe, therefore, that our past notion of synaesthesis must be changed. We must resort to explanations which will do justice to these facts as the most important features of the phenomenon in question. And to do this we must resort to functional reflex mechanisms rather than to organic brain conditions.

The first hint as to a possible reflex theory of synaesthesis may be found in the fact that synaesthesis is not an absolute simultaneous process as it is so often thought to be. Simultaneity comes about after both processes have appeared, in that they persist together, but in their behavior is to be found evidence that a stimulus-response function is operating. The primary process may function either as a stimulus or as a response, usually the former. The secondary process may have both functions under different conditions but usually the function of response, unless it is detached. In all instances the function of the given process depends upon the situation in which it takes place. In case of perceptual synaesthesis the primary process is usually the stimulus and the visual associate is the response. In imaginal synaesthesis the stimulus function of the visual image depends upon the mental activity which has preceded and upon the nature of the implied or explicit *Aufgabe* at the time. In all instances synaesthesis involves a shifting of attention (1) from primary to secondary process; (2) a momentary shift from secondary to primary and back to secondary again; or (3) repeated shifts from one half of the complex to the other, always ending with the visual associate. In no instance are both the secondary and the primary processes attended-to focally; the primary process always seems to be a ''step behind'' attention. In other words, everywhere in the synaesthesis of our subject we found a stereotyped behavior of attention, namely, an inevitable tendency to shift away from primary process to secondary process, the only exceptions being a momentary shift in the reverse direction when the secondary process functioned as a stimulus. Such a stereotyped behavior of attention suggests that in essence the process is a reflex phenomenon. And because of the fact that the associated contents in synaesthesis do not appear associated in like fashion in asynaesthetic individuals we have called this reflex phenomenon a form of conditioned reflex. The inevitable shift or determination of attention toward visual qualities and away from non-visual qualities suggests that a mechanism of irradiation is at bottom responsible. Once a visual synaesthetic image has become detached from its parent process we have the phenomenon of disintegration or dissociation. When this dissociated image appears alone in consciousness but is clarified or rendered more stable by the advent of the primary process we have the phenomenon of facilitation. Stimulus and response functions are interchangeable. A certain muscular contraction in walking for example is at once a response to an antecedent contraction and a stimulus for a subsequent contraction. The visual synaesthetic image may likewise function in either respect. We are unable, however, to offer any reason why a certain color rather than another originally came to be associated with a given tone or other non-visual experience. One would have to know the original circumstances in detail to make such a suggestion. Perhaps one might assume that any given association between sight and sound or sight and touch was due to local functional brain conditions such as differentials in potential energy in different neuron patterns or to synaptic resistance and the like.

We liken synaesthetic processes to conditioned reflexes in that the associations in the former are evidently conditioned. For example a particular shade of blue comes to function as a response to the sound of a tuning-fork rather than as a response to a normal stimulus. We presume such a normal stimulus to be the word ''blue'', an *Aufgabe* process to recall a visual image of blue or the name of some blue object. The conditioned feature of the reflex is its artificial or arbitrary nature. Like the conditioned salivary reflex it is based upon the reflex mechanism of irradiation, presumably; but in synaesthesis we have a widespread tendency toward such irradiation. The visual center in our reagent might be more closely related functionally to the motor projection areas than in normal reagents. Hence any stimulus tending to produce a response leads toward the motor projection areas by way of the visual area.

If such a hypothesis is true it would mean that in observer *A* the physiological processes subserving conscious activities would be somewhat as follows: Assuming at the outset that motor projection areas are quite as important for consciousness as are the so-called ''sensory'' areas, nerve impulses in *A's* case are drained from the various sensory areas toward the motor projection areas through the visual area. The latter evidently possesses a closer functional relation with the motor projection areas than do the other sensory regions. While this view may apparently assume that brain regions account for sensory specificity, there seems to be no reason why such an implication is not safe. Thus a tone is ''seen'' and not ''heard'' as far as meaning is concerned because, in the arousal of a definitized conscious process the visual area functions as the region of integration rather than the auditory. But we must assume, however, that since the sound which is ''seen'' is of auditory origin, the auditory region is as differentiated in function as is the visual, and, prior to the arousal of the visual concomitants, functions to determine in detail the behavior of the visual contents. The fact that no auditory qualities are ''heard'' directly does not necessarily mean that the auditory area lacks differentiation. Rather it means that the lack of ''hearing'' as such is functional and not organic.

Thus with all other sensory modalities it may be that the visual region places its final ''stamp'' upon the content of the resulting conscious process.

This view is suggested further by the fact that kinaesthetic imagery followed by incipient movement does not necessarily involve a visual process until a very high degree of definiteness is attained. It is consistent with the logical necessity of regarding sensory and motor impulses as equally responsible for consciousness and with the view that consciousness is akin to ''motor'' adjustment or possibly an incipient stage of ''motor'' adjustment.

To call synaesthesia a conditioned reflex does not explain the phenomenon. It merely gives it a functional name, or label, which perhaps leads us to an appropriate description of synaesthesis. It will not tell us how the color was substituted for the normal stimulus. We draw upon the notion of irradiation in attempting to solve the latter problem. We cling to the notion of the conditioned reflex *nature* of synaesthesis because it provides for its great variability from individual to individual and for its stereotyped features; and opens a way to envisage more clearly its meaning-function.

After all, as to just what content shall function in a meaning process is an arbitrary and artificial matter as far as the content itself is concerned. The content is only a means to an end in that it is the method or mode by which the function takes place. The contents are conditioned and have no inherent worth as peculiar or unique meaning carriers. For example, most any sort of process from a visual perception to a vocal-motor image may mean a consciousness of a task. The contents concerned in the development and functioning of meaning are conditioned as much as the flow of saliva in response to a tuning fork. As long as the dog's mouth watered in response to a tuning fork in Pavlov's experiments the "tuning-fork-saliva" situation meant "meat." We do not intend to argue in a circle and to imply that meaning is a conditioned reflex because a conditioned reflex is a certain form of arbitrary meaning. We are arguing that the two phenomena are functionally identical.

That meaning is a reflex phenomenon is substantiated on the ground that the former must be a *process*. One mental content must lead to another before meaning is present. This shift, this action, this stimulus-response function *is* meaning. Factors external to the contents determine or condition just what the contents shall be in any given instance. After meaning has once developed it is the inevitable shift from one content to another which is the meaning finally, rather than the contents themselves. We can see no danger in regarding meaning as a conditioned reflex!

It is interesting to note, in passing, that Lowie (6) has drawn a parallel between synaesthesis and peculiar associations which evolve especially among primitive races. For example the Dakota Indians associated "lozenge" with whirlwind; for certain plain's tribes black meant victory or joy; the Cherokees associated "white" with "south," "red" with "east," "black" with "west," and "blue" with "north"; certain figures represented good fortune or prosperity. Primitive man had preferential estimates of certain numbers. Wells (10) sees a possible similarity of function between symbolism, including autistic thinking, and synaesthesis. These are noteworthy recognitions of the significance of synaesthesis as a process of meaning.

Mudge has recently made a brief study of the types and qualities of visual imagery which asynaesthetic subjects associate with musical productions (7). The author apparently assumes, and we believe correctly so, that there is no sharp dividing line between synaesthesia proper and tendencies to associate visual imagery with focalized auditory qualities. But, as our present investigation shows, the synaesthesia which Mudge characterizes as exaggerated differs from the tendency to associate visual imagery with focalized auditory qualities in that in the former the visual associates are necessary in perceiving in auditory fashion. We do not doubt, however, but that such visual associates as Mudge has described assist in the development of meaning, although the investigation does not mention the problem of meaning. It would be practical and more appropriate to confine the term synaesthesia to such acts of perceiving or of comprehending in which the primary process remains non-focal.

VI. SUMMARY

1. Our blind synaesthetic reagent possesses an entoptic phenomenon which is apparently due to inherent retinal light. By means of this phenomenon his synaesthetic colors have apparently been kept "alive." His entoptic colors are clearly distinguishable from his synaesthetic colors. The former are sensations and the latter are images.

2. *A's* synaesthetic imagery differs from his asynaesthetic imagery as follows: (1) It can be held before consciousness indefinitely by resorting to repetitions of the non-visual process for which the synaesthetic imagery stands; (2) it functions independently of specific outline, shape or form for the reason that unlike the asynaesthetic imagery it is not a direct construction of a visual scene or object; (3) it does not function as does other visual imagery as a secondary or supplementary process in connection with

non-visual processes; (4) here attention is invariably centered upon color or brightness first and secondarily upon outline or form while in asynaesthetic imagery size, shape, contour, etc. may be equally important features; (5) synaesthetic imagery functions differently in the development of meaning in that unlike ordinary visual imagery it identifies experiences which in the asynaesthetic individual are non-visual.

3. *A's* visual imagery appears in an entoptic visual setting and on a diffuse and always non-focal kinaesthetic background. *B's* visual imagery invariably appears in a kinaesthetic setting, never in a visual setting. Both reagents agree that visual imagery is more stable when it appears in connection with imagery of other modalities or when accompanied by incipient movement. *B's* visual imagery resolves itself almost at once into tactual, auditory or kinaesthetic processes. It cannot be compared with *A's* in matters of stability, detail, and sequence.

4. Both reagents agree that it is easier to visualize objects which have been handled in tactual-kinaesthetic fashion.

5. In recalling visual imagery *A* uses visual as well as other cues. *B* uses cues which are derived wholly from non-visual modalities.

6. *A's* non-visual imaginal life consists first of an indescribable consciousness which, with the sole exception of kinaesthetic imagery, can become a datum of consciousness only through the medium of visual synaesthetic imagery. *A* knows of the presence of this type of consciousness by means of changes in the behavior of the synaesthetic image. In like fashion he ascribes to this vague consciousness its implied ''attributes'' of quality, intensity, and duration. Without using visual associates he is aware only that ''something'' was present. Further, unless accompanied by visual synaesthetic imagery, there seems to be no possibility of knowing that this parent process ever was present or is present. In other words no image other than visual, with the one exception of kinaesthesis, can stand alone in consciousness. The vague, imaginal parent process is always something from which *A* finds his attention shifting. It is always a ''step behind'' focal attention.

7. These facts, checked against data from *B,* show that synaesthetic imagery in *A's* case function as essential components in the development of meaning and that synaesthetic phenomena are

themselves the development of meaning; they are acts of cognizing. In *B's* case non-visual imagery rises into focal consciousness in the presence of a dominantly kinaesthetic background. As such images develop in his consciousness they are meanings. These meanings are stereotyped. In *A's* case this development of meaning is functionally the same but it involves the presence of a stereotyped visual process. In the two cases the mental contents differ but the functioning of such contents as are present is the same.

8. *A's* early memories are confined exclusively to visual imagery. Experiences originally derived from non-visual modalities are recalled in terms of detached synaesthetic associates. *A* possessed synaesthetic phenomena as far back as he can remember. Original affective experiences are recalled in terms of synaesthetic imagery. Checked against *B's* early memories, *A's* data show that synaesthetic imagery consists of meaningful processes which identify original experiences as auditory, tactual, kinaesthetic or emotional in their origin.

9. While considerable evidence points to the fact that *B's* early memories have undergone considerable change in their content from visual to auditory or to kinaesthetic factors, *A's* early memories have suffered practically no such distortion. Tests over four years of time bear out this fact. *B's* early memories show by contrast the functional significance of synaesthetic processes in *A's* early memories. Evidently the presence of synaesthetic imagery, which is itself stereotyped, has kept *A's* original memory contents free from the usual distortion and elaboration found in the process of forgetting. *B* has found it necessary to elaborate or to distort the original content of his early memories in order to retain meanings, since the original contents have become vague and attenuated through processes of dissociation. But in *A's* case evidences of dissociation are largely confined to the separation of synaesthetic images from their parent processes. Since these detached associates require no such distortion or elaboration as do the asynaesthetic processes of *B* we may look for meaning in the functioning of synaesthetic images themselves. Our introspective data show that this interpretation is justified.

10. *A's* recent memories are almost exclusively visual in their content. It turns out that immediately after any non-visual experience has occurred, its visual associate tends to become detached

from the parent process. The visual associate thereafter dominates in processes of recall. Checked against data from *B* we find that *A's* synaesthetic processes in recent memories function as meanings.

11. A comparison of our reagents' early and recent memories shows that forgetting in *B's* case results in a gradual dominance of kinaesthetic contents and in *A's* case in a sudden dominance of visual synaesthetic images. In the former's case elaboration and distortion provide for the retention of meaning and for its simplification. In the latter's case detached visual synaesthetic images themselves function as meanings, and, being in themselves stereotyped and simple, require no such distortion or elaboration in providing for the retention of meaning.

12. In *A's* processes of imagination in which motor attitudes or incipient bodily adjustments are aroused, kinaesthetic imagery is less quickly translated into visual synaesthetic images than under conditions in which incipient movement does not take place. For the time being kinaesthetic imagery seems to be identified by incipient movement. But if the reagent attempts to attend to these kinaesthetic complexes they at once give way to complexes of visual synaesthetic imagery. The immediate arousal of visual associates is apparently unnecessary when a given non-visual experience leads directly to overt motor adjustments as does the kinaesthetic image. But before this entire process can be "cognized" visual imagery must enter consciousness.

13. In *A's* free associations synaesthetic phenomena function as follows: (a) in the perceiving of the stimulus word; (b) in the persisting of the stimulus word in consciousness together with vocal-motor imagery of the word; (c) as antecedents of further visual imagery; (d) as the responses which are ultimately translated into vocal-motor imagery and innervations of the response word. Evidence of the cognitive functioning of synaesthetic phenomena is found (a) in the fact that a synaesthetic visual image functions in the place of a response word; (b) in the fact that a synaesthetic image aroused by the stimulus word means nothing if it does not lead to a verbal image or to further visual imagery; but that it stands for non-visual imagery if it leads to a response; (c) in the fact that the synaesthetic image must be revived if through faulty attention the reagent fails to perceive the stimulus word; (d) in the fact that the synaesthetic image invariably

plays a dominant rôle in the understanding of the stimulus word; (e) in the fact that synaesthetic imagery frequently determines the direction of the free association; (f) in the false interpretation which the presence of a synaesthetic visual image sometimes leads the reagent to make; (g) in the fact that in recalling the visual associate of the stimulus word during delayed reaction it may seem to the reagent that he is recalling auditory imagery of the word, although no auditory qualities are present to consciousness; (h) in the fact that synaesthetic imagery frequently formed the content of a task consciousness. *A's* procedure, checked against *B's*, reveals the fact that while in *A's* free associations synaesthetic images are present the functional aspects of his responses are identical with those of *B*.

VII. Conclusions

1. Synaesthetic phenomena in the realm of *A's* imaginal life are functionally identical with allied phenomena in his perceptual processes. Synaesthetic phenomena are processes of identifying auditory, tactual, or other non-visual ''images.'' Visual synaesthetic imagery of color or of brightness constitute an invariable and integral component of such ''images.''

2. There exists in *A's* mental life a non-definitized, vague, nonfocal set of experiences which become data of consciousness only through the medium of visual synaesthetic images. It is the ''raw material'' from which definitized images or meanings develop. It is indescribable and is always a step behind attention.

3. The so-called ''secondary sensation'' in *A's* synaesthesia is invariably a visual image.

4. The synaesthetic imagery which functions in imaginal synaesthesia is throughout identical with the synaesthetic imagery which functions in corresponding perceptual synaesthesis.

5. The behavior and the attributes of the visual image in *A's* synaesthetic phenomena reveal the presence or absence of the parent image. This also holds for perceptual synaesthesia.

6. The visual associate fails to identify the parent image in the absence of the latter or when the visual image fails to lead to further mental processes. This holds also for perceptual synaesthesia.

7. The visual associate persists as long as does the primary image and frequently longer. The visual associate may be prolonged or retained indefinitely in consciousness if the reagent succeeds in arousing the primary image. This situation also obtains in perceptual synaesthesia.

8. The intent to attend to the primary image results in a clarification of the visual associate rather than in a focalization of the parent process. When the reagent is instructed to ignore the visual associate both the parent process and the visual associate disappear and the reagent's attention is claimed only by visualized strains of attending. This is also true of perceptual synaesthesia.

9. The only differences which we have found between perceptual and imaginal forms of synaesthesia accrue to the differences by which the two forms are stimulated. In the former a visual image cannot arouse an auditory or tactual perception or lead to a fixation of attention upon an auditory or tactual sensory experience in the absence of peripheral stimulation. In the latter, a visual image may arouse its tactual or auditory parent process.

10. Synaesthesia in our reagent is not confined to the field of perception; it is a cognitive process *per se,* pervading his entire mental life as far as it has been studied; functionally it differs in no respect from any process of meaning. Synaesthesia is a process of meaning.

11. Synaesthesia is not a freak phenomenon the explanation of which is to be sought in a unique organic condition of the brain such as anastomosis or tangling of fibers, lack of differentiation of function, circulation of the blood and the like. It is a normal mental function whose contents alone differ from the contents of similar functions in the asynaesthetic individual. In our reagent, at least, synaesthesia is not a surplus process but an essential one.

12. The behavior of synaesthesia together with its function in mental life suggest that it is a form of conditioned reflex. The conditioned features of these reflexes are the mental contents which have become stereotyped.

13. The various arguments which have been advanced in the past in favor of physiological theories of synaesthesia point to the cognitive nature of the phenomenon rather than to its organic nature.

14. It is suggested that the development of a conscious activity requires discharges from the motor projection areas of the brain; that in the act of becoming conscious of anything, in *A's* case, the visual area drains from all other sensory regions the impulses there set up by stimulation. In this way impulses which subserve the development of mental activities all pass through the visual area on their way to the motor area. This gives to *A's* consciousness its dominantly visual character.

15. The view that synaesthesis is cognitive harmonizes the facts which support the antagonistic physiological and association theories.

16. We believe that in our synaesthetic reagent's non-visual experiences we have found processes of the type which we assume characterizes consciousness at birth and of the type which characterizes the consciousness of an individual who has matured but who has suffered total amnesia and has been obliged to begin mental life practically all over again. In other words synaesthesis gives us an opportunity for studying as directly as is possible consciousness in its ''undeveloped'' or ''undifferentiated'' state, the state of the abstract sensation. In our reagent it is quite evident that imaginal as well as sensory processes have a direct root in an indescribable and cognitively undifferentiated type of consciousness.

NOTE

As this monograph goes to press, research work is being done on four sighted, synaesthetic reagents. While none of these reagents are trained introspectors such data as have been gathered confirm the following results: (1) Synaesthesia occupies the same functional place in the higher thought processes as it does in perceiving; (2) synaesthesia is a phenomenon of meaning; (3) the reagent does not become aware of the primary process until attention is directed to the secondary process; (4) the secondary process—the image—is not an incidental association; it is a content essential to the reagent's acts of cognizing.

In none of these four reagents is the synaesthesia as wide-spread as in our synaesthetic blind reagent and where, in the former, mental contents are asynaesthetic, meaning functions and develops as it does in the asynaesthetic person.

It is worth mentioning in passing that throughout this series of investigations we have found no possible clue that the mental processes of the blind are in any way different from the mental processes of sighted persons. Differences are confined wholly to contents and not to functions. It is obviously an injustice to segregate the blind, during their periods of education, from normal social intercourse with sighted persons and sighted children.

We have included in this monograph more introspective data than was perhaps essential to demonstrate our statements in the text. This was done for the reason that our psychological literature is lacking in data on the mental life of the blind. It is hoped that from the introspections herein may be noted the detailed and intensely interesting facts concerning the behavior and characteristics of imaginal processes in the blind. The monograph has run to such length that the writers felt it unwise to attempt here a summary of these facts inasmuch as the purpose of the research was not to study the mental life of the blind but the phenomenon of synaesthesia. A detailed analysis of much of this imagery is to be found in the main body of the text. To those who are interested we extend a hearty welcome to use these introspections toward the fulfilling of such purposes as they desire.

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MENTAL DIFFERENCES IN CERTAIN IMMIGRANT GROUPS

Psychological Tests of South Europeans in Typical California Schools with Bearing on the Educational Policy and on the Problems of Racial Contacts in This Country

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MENTAL DIFFERENCES IN CERTAIN IMMIGRANT GROUPS

CHAPTER I. PLAN AND PURPOSE OF THIS STUDY

The so-called ''New Immigration'' which has deluged this country in the past thirty or forty years has resulted in many problems—social, economic, racial and educational. Only lately has serious attention been paid to the last two: in reference to the first the consequences of racial mixture of the older and newer stocks, and in regard to the second, the problem of providing the children of foreign stock and adult immigrants with an education commensurate with modern needs and along the lines laid down in our national culture. The educational difficulties have been reflected in great retardation and in great burden of teaching the foreign children the content of our curricula.

The incentive to this study grew out of an attempt to discover if possible some of the causes of the difficulty in the education of children of South European ancestry in our public schools and further to see if a study of these children of immigrants might not throw some light on the larger question of adult immigration. The purposes of this research are: (1) To investigate by psychological tests and other measures the mental capacity of the South Italian, Portuguese and Spanish-Mexican children in certain public schools, to discover whether their inability to master the traditional American education is due: (a) to their alleged language handicap, or (b) to the lack of native mental endowment (as compared to that of ''American'' children of North European ancestry) which prevents their acquisition of the content of our curricula. (2) From the results of the study of the school population to note the possible implication of the findings for the larger problem of immigration and the future race mixture in this country.[1]

The results will be treated in a comparative way in order to bring out the differences in the native ability and performance of the various groups.

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[1] Race will be used in this monograph in the semi-popular sense. Cf. Reuter (89) and Retzius (88). Technically in speaking of Europeans we should employ the term "sub-race." "Race" as used here has a common sanction in much sociological and psychological writing. The term "American" will be used to refer to the children of North European ancestry. "Latin" will be used when speaking of the South Italians, Portuguese and Spanish-Mexicans as a group. "Non-Latin" will occasionally be used to designate the children of North European background in contrast to the South Europeans and to avoid stereotyped expression.

Variation in given traits in a group of individuals has long been recognized in biology. Variability in human height, weight, cephalic index and other strictly physical features is readily admitted. More recently has arisen the idea that in men and women mental traits vary considerably around an ''average'' and that further the dispersion in mental traits as well as the averages differ in different groups, classes and possibly races. The prejudices against measuring the ''mind'' are disappearing. It seems to the writer that mental measurement has come to stay and that the application of mental tests is apt to be increased rather than lessened. Certainly no one in the field of testing is ignorant of the long way yet to be covered before the desirable accuracy is obtained. The methods of measuring general intelligence of groups have proved their practical worth through their use in schools, in the recent draft army, in industry, in mental pathology and elsewhere.

The writer accepts, with reservations as to perfection and complete applicability, however, the use of tests of general intelligence as valid for studying the native mental endowment of a school population. It must, of course, be borne in mind that the specific groups which were tested in this study are from one section of the country only. This study is not one of a complete racial group. The particular sample is typical of like groups in other parts of the United States so far as may be determined.

Further, at the outset, the writer accepts as valid two concepts of modern biology and psychology: (1) that of general intelligence; (2) that mental traits are in very considerable measure transmitted by the mechanisms of heredity, and hence exist *relatively* independent of the effects of environment. It it not the purpose at this point to go extensively into the theory of general intelligence or to review the literature on mental inheritance and discuss the problem of heredity versus environment. Nevertheless, for perspective, brief mention will be made in the following paragraphs of these two assumptions.

A. The Nature of General Intelligence.[2]

There exists in the human organism a general inherent capacity or potentiality for adjustment to the environment. Ultimately successful life will be in terms of adequate or inadequate possession of such potentiality. This potentiality is not an instinct, but may be thought of as a sum total of more or less non-specific possibilities for the development of behavior patterns. The actual development of these behavior patterns, however, depends on the type of contacts the individual makes with his environment as he grows up. Although the specific content and meaning in human minds varies, the kind of adjustment "crises" met by any person or group of persons is much the same, and, by and large, the organization of the human mind may be considered fairly common everywhere. Yet in terms of advancement, that is to say, increasingly efficient adjustment, comprising the rise of the arts and sciences making for survival, the groups containing many persons of better than group-average capacity for what might be called projection of behavior into future situations are bound to get ahead, other things being equal, as compared to a group comprising but few individuals of better than average ability. By projection of behavior is implied such factors as: free imagery, comprehension, wider meanings, analyzing and synthetizing ability, symbolic thinking, foresight, interpretation. A combination of higher than average ability and wide variability in one group than in a second would give the former decided advantage over the latter, provided the cultural opportunities of both groups were similar.

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[2] Cf. for general treatises Binet and Simon (8), Terman (110, 111, 113), Goddard (45, 46), also the Symposium on Intelligence (108), Henmon (50), Kohs (61), Doll (32), Stockton (102), Mitchell and Ruger (74).

The rapid spread of cultural advantages through education and civilization generally is making it possible for the various racial groups to possess somewhat identical social heredity. Progress lies with those groups who have the stronger potential power for using and enhancing this. As Terman puts it (112, p. 128):

> It cannot be disputed, however, that in the long run it is the races which excel in abstract thinking that eat while others starve, survive epidemics, master new continents, conquer time and space, and substitute religion for magic, science for taboos and justice for revenge. . . . Any given society is ruled, led, or at least molded by the five or ten per cent of its members whose behavior is governed by ideas.

While the formal definitions of general intelligence have varied among themselves, the disagreements have usually been purely on emphasis rather than on essentials. Thorndike (122) has held for a mutliple or non-focal notion of intelligence while others have held to a unifocal or common factor belief. One feature of Thorndike's point of view has bearing upon this study. He has maintained that there are at least two types of ability: one which is largely mechanical in its bent, the other ideational. Stockton (102) has attacked this problem of two types of intelligence and found that there does seem to be two levels of behavior; one he terms *perceptual,* the second, *conceptual.* He shows from experimental results that those pupils who perform best on the ''conceptual'' level tend to do poorly on the ''perceptual'' simply because they are handicapped in dealing with the concrete tasks of the latter, in view of their more highly integrated imagery, symbolic images, wealth of associative processes,—in short more elaborate ''central processes.''

According to Stockton the notion of ''kinds of intelligence'' must be reduced rather to the more satisfactory concept of different degrees in the organization of intelligence. We want to know how effective the mental processes are in leading to successful adjustment. These processes may be either concrete, perceptual organization or a higher integration of mind in terms of ''symbolic thinking,'' use of language, analysis and synthesis. In brief it is just those that have capacity to deal with problems in terms of symbols and meanings, of comprehension and interpretation, that have on the whole most successfully used the products of civilization and have gone on to enhance them. In modern complex society the better organized, more efficient degree of intelligence is especially needed.

B. Inheritance of Mental Traits.

The hereditary aspect of this problem is not so certain. The bearing of the inheritance of mental traits on the second problem outlined above is obvious.[3] If the intelligence of the incoming immigrant should prove below the average of the native white American, does it indicate anything concerning the distribution of intelligence in the next generation of the particular immigrant stock? If on the other hand, intelligence is the resultant of the forces of environment acting on a practically common heredity everywhere in society, may we not anticipate a change in the average intelligence of the second generation from the immigrant, and in view of good surroundings—education, uplift, Americanization, and industrial ''good times''—an increasing shifting in the variability, if not in the central tendency of intelligence toward higher ability? Now it must be admitted at once that our knowledge of the inheritance of mental traits is not so definite as we desire. However, careful studies of the matter are pushing us to the conclusion not only that there are levels of general intelligence in the population but that these are fairly constant, at least much more constant from generation to generation than we have been inclined to believe. It is true that the elimination of all the factors of environment, especially the effects of unfavorable circumstances in the formative years of life which may bring complexes, and habits that later opportunities can not eliminate, should make us cautious of too wide assumptions on the question. Still the evidence at hand on the effect of heredity independent of environment can not be ignored.

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[3] If there is nothing to mental inheritance, then any differences in mentality revealed by tests of foreign children would apply only to first and possibly second generation of pupils in the schools. If mental heredity be a fact, then our results may have profound significance for our national well-being—educational, political, and cultural.

The pioneer work of Galton (42) and DeCandolle (28) on hereditary genius led the way to the later investigations. Since Galton, the outstanding contributions have come from Pearson[4] (78), Ellis (37), Davenport (26), Woods (136), Goddard (45), Starch (101), Thorndike (119) are best known. A phase of this matter of the stability of intelligence under varying environmental opportunities is of interest. Boas arguing for the slight effect which heredity in mental traits plays in racial differences as contrasted to the influence of environment writes (9, p. 103):

> It is one of the fundamental laws of psychology that the repetition of mental processes increases the facility with which these processes are performed.

If Boas is arguing, as he apparently is, that practice will tend to wipe out differences in performance of a set of individuals of same age, he is mistaken. That is, mere educational and cultural opportunities will not eliminate those differences in individuals that appear to be innate. Starch cites some research into the relation of learning in school subjects to intelligence, showing that the relative differences in persons is enhanced, not diminished, by practice (101, p. 91):

> All experimental results point in the direction that practice does not equalize abilities. . . . The gifted individuals profit more, both relatively and absolutely, than the less gifted. This experimental fact is one of the most profound bits of evidence regarding the whole problem of heredity and environment.

Conclusive results of a study by Ruch (94) on this very problem show that on material demanding the "higher thought processes" practice reveals increasing wider differences in the responses of three groups of individuals: poor, medium, and superior in intelligence. That is, the advantage is all to the favor of the latter two groups and not the first, and moreover the last group does not only absolutely but relatively better than the second even. It would seem then that Boas' statement must be modified to take into account the effect of levels of intelligence upon the increase in the "facility" of handling problems demanding intelligence.

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[4] Cf: Yule (145) for criticism of certain findings of Pearson.

Whatever be the individual nature of the carriers of this potentiality in human beings, we must accept the facts that intellectual traits are to considerable if not complete degree transmissible by and subsumable to the laws of heredity. One need not nor can not conclude with certain writers that the matter is all heredity and nothing else.[5] Neither are mental differences in groups and races due alone to adventitious effects of environment. The evidence is strong that the mixture of family strains of weak mentality affects the capacities in the forthcoming generations. The same laws must hold for the crossing of family strains of various racial or sub-racial strains. We may justly then at the conclusion of this investigation at least raise the implication of the possible effect of racial mixture in this country between various immigrant stocks as we *actually find them* in this country. This is truly a supplementary feature to the monograph, but its consequences are large and the writer believes he is justified in raising the issue.

In brief, then, there are two assumptions fundamental to our purpose: the first regarding general intelligence bears upon the experimental method and the interpretation of the results for educational ends; the second bears by implication, at least, upon the interpretation of the results for the wider problems of immigration, racial mixture and future cultural progress.

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[5] Cf: Sumner (105), who held the thesis that there were great individual differences in people and attempted to show the influence of free land and economic opportunity on the beliefs in man's innate "equality." Ward (127) held the view that environment and opportunity account for most of the differences in mentality of groups. Cf: also Davies (27), whose book attempts to show that mental superiority is dependent on environment. His arguments might go to prove quite the contrary. One can scarcely hold with Galton that all genius "will out." This is to ignore the influence of cultural level and "run of attention." Cf: *infra*, Chap. V.

CHAPTER II. METHODS AND MATERIALS

A. Selection of the Sample.

Since the problem before us is one of general mental ability in racial groups, a selection of children by age rather than grade was made. There is no need of defending at length this decision, which though in little use in educational surveys, is based upon good statistical principle. To take an age group and test all the children in a school system of this age furnishes a better sample from which to work in comparing groups than any method of selection by grade. The age to choose was a problem, but after considering the availability of sample, the withdrawal from school of children after 13 or 14 years, it was decided to select all children who had passed their twelfth birthday and were not yet thirteen. Moreover this group did not include many who had entered adolescence and hence the difficulties of possible emotional instability were removed. Then, too, the practical cessation of immigration from Europe in 1914 meant that there was a considerable interim of no-immigration into the South European neighborhoods, and hence the possible likelihood of getting twelve-year-olds who had but recently arrived in the country and knew no English did not arise. Moreover, as it turned out, practically all the cases tested were born in this country. Of those born abroad, at least so far as the South Italians are concerned, all but two or three had been in the United States over five years. These few had been here at least three years. The individual records of these cases shows that they were not particularly handicapped by the language difficulty.

TABLE I. BIRTHPLACE OF GROUPS[6] (Percentages born in countries indicated)

Race Group	U. S.	Italy	Portugal	Spain	Mexico	Hawaii
American (S. J.)	99.5					
Italian (S. J.)	84.5	14.8				
Portuguese	88.5		3.8			7.7
Spanish-Mexican	73.5			22.6	1.9	
Italian (Miscellaneous)	86.0	14.0				
American (Miscellaneous)	97.8					

(N. B. The balance of percentages not indicated were born elsewhere.)

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[6] Certainly to be born in this country may not mean contact with American life; yet the school attendance, contacts in play and work often help the child born in this country, of foreign parentage, over the handicap of home environment where the parents continue to speak the native tongue.

The communities studied were: San Jose, Santa Clara, South San Francisco, Sunnyvale, Half Moon and Milpitas. All these cities and towns had a relatively high percentage of population of South European ancestry, while the bulk of the remaining population was of older standing in the communities and of Northern European background: English, German, Scandinavian almost completely. The following percentages of population of this latter background compared with that of the various South European are typical: For San Jose, Northern European ancestry ("Americans"), 56.5 per cent; South Italian, 35.3 per cent; Portuguese, 2.1 per cent and Spanish-Mexican, 5.9. Corresponding figures for Santa Clara are: 37.4; 5.8; 39.0; 20.7. For South San Francisco: 27.0; 57.1; 14.2; 1.0.

B. Selection of Psychological Tests.

Since it was the purpose in this study to handle rather large numbers of cases, and to select tests which would answer the question of alleged language handicap, the Binet test was out of the question. We chose two group tests, one decidedly verbal in its make-up, the other purely performance and not dependent on knowledge of English for its successful manipulation. The first, the army alpha, differentiates mentality down to ten years mental age or slightly lower perhaps. It would outreach the mentality of any superior child found in the group. The correlation of -|- .99 of alpha with Binet in the army testing proves the satisfactoriness of the test for diagnosis of groups (73, p. 99). The other test, beta, was the best performance test available. The procedure was modified slightly over that given in the army to permit instructions to be given in simple language rather than by pantomime as was done in the former case. The method of presenting typical forms and demonstrating was continued. Then came simple verbal expression, for example: "Look at your papers, Test Six. Draw in the missing parts as I did on the board."

C. Outside Criteria.

To check the statistical results from the tests, data on grade location, teachers' estimates of school work and of intelligence were collected. Also the occupations of the parents, for a possible cue to the influence of economic level on the standing in the tests. The scale for making these various estimates will be noted when the results of the data are presented.

D. The Administration and Scoring of the Tests.

The tests were given by the writer himself. All precautions possible to make for uniformity of conditions were taken. Ventilation, lighting, presentation of test material itself—these and allied factors were carefully guarded. Alpha was usually given first, followed by beta within the same week or at the outside two weeks later. The children were selected by means of teachers' registers, as well as by enquiring of children themselves the facts on their ages. In doubtful cases, school nurses and principals were called in to determine from parents the child's age. Out of nearly 1000 children tested, only 20 children were eliminated for ages incorrectly given. If a child missed one of the two tests, attempts were made as soon as he returned to school to test him. The children manifested keen interest in the whole procedure. Discipline and esprit de corps were excellent. The groups were usually of fifty or less. Only in two instances did the writer attempt, with the help of teachers and fellow graduate students, to give the test to as many as 100 children at once. There is no evidence whatever that the administration of the tests by a stranger had any detrimental effects. The writer became a very familiar person about the school buildings and grounds during the course of an entire school year and the children were always courteous and interested in what he was doing.

The tests were scored by trained assistants and by the writer himself. Later the computations in individual tests were checked on adding machine, and a large random sample of the tests themselves were re-scored. Errors were slight if any.

E. The Materials.

The following tables present the raw data of the study grouped into convenient units.[7] "S. J. American" refers to the children of North European ancestry from San Jose, California; "S. J. Italian" refers to the South Italians from the San Jose schools; ''Miscellaneous American'' refers to the children of Northern European ancestry from the other localities outside of San Jose; ''Miscellaneous Italian" in similar fashion comprises the South Italians from communities other than San Jose. For Portuguese and Spanish-Mexican children they came at random from all the localities.[8]

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[7] Except for the distribution in grades which is given in percentages in the next chapter.

[8] The San Jose American and San Jose Italian children were kept separate for comparative purposes. And the Miscellaneous groups furnished control groups for checking on results from San Jose. Misc. will be used to abbreviate Miscellaneous. A will be used in some instances as an abbreviation of alpha, and B for beta. Statistical abbreviations follow common practice.

TABLE II. DISTRIBUTION OF TEACHERS' ESTIMATES, PARENTS' OCCUPATIONS, S. J. AMERICAN CHILDREN

—1—		—2—		—3—		—4—	
M of Two Est. Intel.	No. Pupils	M of Two Est. Schwk.	No. Pupils	Taussig Occp. Sc.	No. Pupils	Barr Occp. Sc.	No. Pupils
1	3	1	9	5	27	12	10
1.5	10	1.5	6	4	100	11	14
2	35	2	23	3	120	10	28
2.5	27	2.5	16	2	51	9	51
3	45	3	39	1	18	8	43
3.5	42	3.5	45	Total	316	7	62
4	80	4	76			6	30
4.5	30	4.5	38			5	46
5	27	5	35			4	31
5.5	9	5.5	10			3	1
6	5	6	15				
6.5	2	6.5	2				
7	1	7	2				
Total	316	Total	316			Total	316

TABLE III. ALPHA, BETA, AND COMBINED ALPHA AND BETA TEST DISTRIBUTIONS, S. J. AMERICAN CHILDREN

A Scores	Total	B Scores	Total	Comb. A. & B. Scores	Total
150-159	1	95-99.5	5	220-239.5	1
140-149		90-94.5	2	200-219.5	6
130-139		85-89.9	13	180-199.5	13
120-129	2	80-84.5	31	160-179.5	46
110-119	10	75-79.5	34	140-159.5	56
100-109	16	70-74.5	58	120-139.5	58
90- 99	21	65-69.5	60	100-119.5	56
80- 89	34	60-64.5	36	80- 99.5	44
70- 79	30	55-59.5	27	60- 79.5	19
60- 69	42	50-54.5	18	40- 59.5	6
50- 59	34	45-49.5	15		
40- 49	49	40-44.5	4		
30- 39	33	35-39.5	4		
20- 29	25				
10- 19	13				
0- 9	4				
Total	314	Total	307	Total	305

TABLE IV. DISTRIBUTION OF TEACHERS' ESTIMATES, PARENTS' OCCUPATIONS, S. J. ITALIAN CHILDREN

—1—		—2—		—3—		—4—	
M of Two Est. Intel.	No. Pupils	M of Two Est. Schwk.	No. Pupils	Taussig Occp. Sc.	No. Pupils	Barr Occp. Sc.	No. Pupils
1.0		1.0		5		10	7
1.5	1	1.5	3	4	25	9	13
2.0	5	2.0	3	3	32	8	4
2.5	7	2.5	2	2	37	7	9
3.0	10	3.0	20	1	102	6	15
3.5	21	3.5	16	Total	196	5	38
4.0	48	4.0	51			4	74
4.5	22	4.5	25			3	35
5.0	40	5.0	36			2	1
5.5	18	5.5	19				
6.0	16	6.0	6				
6.5	2	6.5	8				
7.0	6	7.0	7				
Total	196	Total	196			Total	196

TABLE V. ALPHA, BETA, AND COMBINED ALPHA AND BETA TEST DISTRIBUTIONS, S. J. ITALIAN CHILDREN

A Scores	Total	B Scores	Total	Comb. A. & B. Scores	Total
90-94	2	95-99.5	1	160-179.5	4
85-89		90-94.5		140-159.5	6
80-84	2	85-89.5	1	120-139.5	12
75-79	1	80-84.5	7	100-119.5	35
70-74	4	75-79.5	6	80- 99.5	39
65-69	3	70-74.5	13	60- 79.5	36
60-64	5	65-69.5	24	40- 59.5	35
55-59	2	60-64.5	25	20- 39.5	17
50-54	7	55-59.5	19	0- 19.5	3
45-49	12	50-54.5	25		
40-44	14	45-49.5	23		
35-39	15	40-44.5	10		
30-34	12	35-39.5	15		
25-29	18	30-34.5	6		
20-24	16	25-29.5	8		
15-19	15	20-24.5	5		
10-14	22	15-19.5	2		
5- 9	20	10-14.5	1		
0- 4	21	5- 9.5			
		0- 4.5	1		
Total	191	Total	192	Total	187

TABLE VI. DISTRIBUTION OF TEACHERS' ESTIMATES, PARENTS' OCCUPATIONS, PORTUGUESE CHILDREN

—1—		—2—		—3—		—4—	
M of Two Est. Intel.	No. Pupils	M of Two Est. Schwk.	No. Pupils	Taussig Occp. Sc.	No. Pupils	Barr Occp. Sc.	No. Pupils
1.0		1.0		5		10	14
1.5		1.5		4	21	9	5
2.0	1	2.0	2	3	8	8	
2.5	1	2.5	1	2	15	7	3
3.0	3	3.0	2	1	34	6	3
3.5	6	3.5	4	Total	78	5	15
4.0	12	4.0	20			4	19
4.5	14	4.5	17			3	19
5.0	14	5.0	20				
5.5	13	5.5	5				
6.0	7	6.0	3				
6.5	5	6.5					
7.0	2	7.0	4				
Total	78	Total	78			Total	78

TABLE VII. ALPHA, BETA AND COMBINED ALPHA AND BETA TEST DISTRIBUTIONS, PORTUGUESE CHILDREN

A Scores	Total	B Scores	Total	Comb. A. & B. Scores	Total
95-99	1	90-94.5	1	180-199.5	1
90-94	1	85-89.5	1	160-179.5	2
85-89	1	80-84.5	1	140-159.5	3
80-84	2	75-79.5	1	120-139.5	5
75-79		70-74.5	5	100-119.5	11
70-74		65-69.5	9	80- 99.5	9
65-69		60-64.5	6	60- 79.5	18
60-64		55-59.5	8	40- 59.5	17
55-59	3	50-54.5	10	20- 39.5	7
50-54	7	45-49.5	10	0- 19.5	1
45-49	1	40-44.5	8		
40-44	2	35-39.5	3		
35-39	6	30-34.5	8		
30-34	4	25-29.5	2		
25-29	7	20-24.5	1		
20-24	7	15-19.5			
15-19	7	10-14.5			
10-14	6	5- 9.5			
5- 9	9	0- 4.5	1		
0- 4	13				
Total	77	Total	75	Total	74

TABLE VIII. DISTRIBUTION OF TEACHERS' ESTIMATES, PARENTS' OCCUPATIONS, SPANISH-MEXICAN CHILDREN

—1—		—2—		—3—		—4—	
M of Two Est. Intel.	No. Pupils	M of Two Est. Schwk.	No. Pupils	Taussig Occp. Sc.	No. Pupils	Barr Occp. Sc.	No. Pupils
1.0		1.0		5		10	2
1.5	1	1.5		4	4	9	2
2.0		2.0	2	3	12	8	2
2.5	1	2.5	1	2	16	7	4
3.0	2	3.0	3	1	21	6	6
3.5	4	3.5	2	Total	53	5	16
4.0	8	4.0	17			4	13
4.5	15	4.5	6			3	8
5.0	8	5.0	11				
5.5	6	5.5	7				
6.0	3	6.0	2				
6.5	2	6.5	1				
7.0	3	7.0	1				
Total	53	Total	53			Total	53

TABLE IX. APLHA, BETA AND COMBINED ALPHA AND BETA TEST DISTRIBUTIONS, SPANISH-MEXICAN CHILDREN

A		B		Comb. A. & B.	
Scores	Total	Scores	Total	Scores	Total
65-69	2	80-84.5	2	140-159.5	1
60-64	2	75-79.5	1	120-139.5	6
55-59	3	70-74.5	4	100-119.5	4
50-54	1	65-69.5	8	80- 99.5	12
45-49	1	60-64.5	1	60- 79.5	13
40-44	3	55-59.5	8	40- 59.5	10
35-39	3	50-54.5	7	20- 39.5	4
30-34	4	45-49.5	8	0- 19.5	1
25-29	6	40-44.5	4		
20-24	3	35-39.5	5		
15-19	4	30-34.5	1		
10-14	6	25-29.5	1		
5- 9	7	20-24.5	1		
0- 4	6	15-19.5	1		
		10-14.5			
		5- 9.5			
		0- 4.5	1		
Total	51	Total	53	Total	51

TABLE X. DISTRIBUTION OF TEACHERS' ESTIMATES, PARENTS' OCCUPATIONS, MISC. ITALIAN CHILDREN

—1—		—2—		—3—		—4—	
M of Two Est. Intel.	No. Pupils	M of Two Est. Schwk.	No. Pupils	Taussig Occp. Sc.	No. Pupils	Barr Occp. Sc.	No. Pupils
1.0		1.0		5		10	7
1.5	1	1.5	1	4	19	9	9
2.0	1	2.0	1	3	6	8	1
2.5	1	2.5	1	2	12	7	4
3.0	4	3.0	3	1	20	6	1
3.5	4	3.5	9	Total	57	5	21
4.0	7	4.0	10			4	7
4.5	10	4.5	9			3	7
5.0	10	5.0	8				
5.5	10	5.5	6				
6.0	5	6.0	4				
6.5	3	6.5	4				
7.0	1	7.0	1				
Total	57	Total	57			Total	57

TABLE XI. ALPHA, BETA AND COMBINED ALPHA AND BETA TEST DISTRIBUTIONS, MISC. ITALIAN CHILDREN

A		B		Comb. A. & B.	
Scores	Total	Scores	Total	Scores	Total
100-104	1	80-84.5	1	160-179.5	1
95-99		75-79.5	1	140-159.5	2
90-94	1	70-74.5	5	120-139.5	2
85-89		65-69.5	7	100-119.5	5
80-84		60-64.5	5	80- 99.5	16
75-79		55-59.5	8	60- 79.5	13
70-74	2	50-54.5	11	40- 59.5	11
65-69		45-49.5	2	20- 39.5	4
60-64		40-44.5	7		
55-59	1	35-39.5	2		
50-54		30-34.5	2		
45-49		25-29.5	3		
40-44	3				
35-39	2				
30-34	8				
25-29	5				
20-24	10				
15-19	9				
10-14	6				
5- 9	3				
0- 4	6				
Total	57	Total	54	Total	54

TABLE XII. DISTRIBUTION OF TEACHERS' ESTIMATES, PARENTS' OCCUPATIONS, MISC. AMERICAN CHILDREN

—1—		—2—		—3—		—4—	
M of Two Est. Intel.	No. Pupils	M of Two Est. Schwk.	No. Pupils	Taussig Occp. Sc.	No. Pupils	Barr Occp. Sc.	No. Pupils
1.0		1.0		5	5	12	2
1.5	3	1.5	2	4	22	11	3
2.0	3	2.0	5	3	43	10	11
2.5	4	2.5	3	2	12	9	13
3.0	9	3.0	10	1	8	8	2
3.5	8	3.5	8	Total	90	7	32
4.0	37	4.0	29			6	7
4.5	15	4.5	16			5	14
5.0	4	5.0	11			4	4
5.5	2	5.5	3			3	2
6.0	4	6.0	3				
6.5	1						
Total	90	Total	90			Total	90

TABLE XIII. ALPHA, BETA AND COMBINED ALPHA AND BETA TEST DISTRIBUTIONS, MISC. AMERICAN CHILDREN

A		B		Comb. A. & B.	
Scores	Total	Scores	Total	Scores	Total
100-109	1	95-99.5	2	180-199.5	1
90-99	11	90-94.5	1	160-179.5	13
80-89	6	85-89.5	4	140-159.5	15
70-79	15	80-84.5	4	120-139.5	23
60-69	13	75-79.5	9	100-119.5	14
50-59	12	70-74.5	15	80- 99.5	9
40-49	8	65-69.5	13	60- 79.5	5
30-39	10	60-64.5	14	40- 59.5	2
20-29	4	55-59.5	11	20- 39.5	2
10-19	4	50-54.5	2		
0- 9	4	45-49.5	5		
		40-44.5	3		
		35-39.5			
		30-34.5	2		
		25-29.5			
		20-24.5	1		
Total	88	Total	86	Total	84

CHAPTER III. TREATMENT OF RESULTS

1. Preliminary Survey[9]

The original American settlers in the Santa Clara valley were almost entirely of North European ancestry, with the bulk of them specifically English or German in descent. There have been in these communities, however, for long periods a small minority of both French and Spanish. The school problem for this population was similar to that found in typical northern and western American towns and villages of the period after the Civil war. About 1890 there began a considerable incursion of immigration of South European and Mexican sources, and since 1900 this movement has been very large, until now the communities possess a noticeable percentage of foreign-born persons or persons of foreign-born parentage.

San Jose offers throughout this thesis the chief center of material, and will be used here for a brief summary of the pertinent history of the school problem we are attempting to solve. The Italian constitutes the largest group of foreigners in San Jose, and his incoming has been along the periphery of this medium-sized city of 30,000 or so, at those geographical points where the city proper touches the surrounding agricultural districts, with its rich vegetable and fruit products. Here are located not only many of the finest prune ranches and tomato tracts, but also the canneries and other industrial plants that serve to supplement the purely agricultural pursuits of the laboring population. In time the Italians and to less degree the Portuguese and Spanish-Mexicans have encircled San Jose absorbing entire sections until in the districts comprising two-thirds of the city's boundaries are found large and populous neighborhoods occupied almost without exception by the Italian families.

This dislocation of the population of these neighborhoods, which has been so typical in all American cities facing a similar situation, had profound and serious effects upon the public schools. The Italian especially of all the groups we are studying is ambitious for "a stake in the land" and his efforts with those of his children are bent on this purpose. The Portuguese is much less desirous of land ownership and much more mobile, and likewise the Spanish-Mexican groups are transient on the whole compared to the South Italian.

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[9] This section is somewhat abbreviated from the longer and more complete history in the original typewritten thesis now in the Stanford Library.

The effects on the school are noticeable in three particulars: (1) school discipline, (2) teaching problem, (3) retardation. All three are closely related to the one outstanding feature: the difference in educability of the child of foreign parentage and the child of North European ancestry. In discipline the problem was one of dealing with temperamental differences in the groups, and in enforcing school attendance. The parents of the Italian, Portuguese and Spanish-Mexican children little realized the American *mores* on the place of education in our life. Their interests being immediately economical, the attendance laws had to be vigorously enforced. In the case of San Jose and Santa Clara, the last five years, at least, has seen a very determined and successful attempt to bring the child of foreign parentage into the school and to keep him there. The long tenure of certain well-qualified principals and teachers has assisted in this matter. The teaching problem became really one of dealing with children of different cultural backgrounds, and in the first few years many of them had difficulty acquiring the use of the English which is the key instrument to the acquisition of the elementary curricula. No attempt was made beyond observational method to rate the teaching efficiency of the school systems studied. So far as San Jose, Santa Clara, Sunnyvale and South San Francisco are concerned the teaching there was average considering the somewhat crowded conditions in the class-rooms and a somewhat ancient rule of pedagogical procedure. The principals in the schools attended by the foreign children were all exceptionally alive to their problem, and rearrangements of sections, rooms for retarded and backward, and such usual makeshifts were in use. In the case of the schools in more rural districts, like Half Moon and Milpitas, the handicaps of the ordinary country school were more apparent; several grades to a teacher, lack of equipment and poor compensation. But even in these cases the work was pretty high calibre, for these communities are in well-regulated parts of the state whose entire school system is in the first rank of our country.

Facts of retardation furnish the most convenient presentation of the educational situation. Certain sample facts were collected on age-grade distributions in San Jose and Santa Clara which throw into relief at once the crux of our problem. The following tables summarize the matter for the entire city of San Jose and especially for four schools which serve as samples of the entire system there. Schools A and B are attended largely by children of North-European ancestry, and C and D by Latins. The amount of retardation in the specific race groups was not available. We have followed the Ayres method of computing retardation (3, ch. 4) but in one column have given the figures for retardation in these schools if three years rather than two be "allowed" for normal progress. The differences between the sample "American" schools and the sample "Latin" schools is still quite as marked, when three years is allowed for passing a given grade.

TABLE XIV. RETARDATION IN CERTAIN SCHOOLS IN SAN JOSE, 1919-20

School	No. Pupils	No. Retard.	Per Cent Retard. (Ayres)	Per Cent Retard. (3-yr. Scale)	Per Cent Latins in Schools
Total San Jose	4939	2098	42.4	20.3	40.0
School A	652	177	27.1	9.8	16.1
School B	629	187	29.7	12.1	17.5
School C	770	399	51.8	26.8	81.4
School D	744	464	62.1	38.4	72.4

TABLE XV. COMPARATIVE RETARDATION BY GRADE IN SCHOOLS A, B, C AND D; ALSO PERCENTAGE OF PUPILS IN THE VARIOUS GRADES

1. For Schools A and B Together

Grades	No. Pupils	No. Retard.	Per Cent Retarded	Per Cent in Grades
I	212	29	13.7	16.5
II	150	33	22.0	11.7
III	149	49	32.9	11.7
IV	137	50	36.5	10.7
V	161	59	36.6	12.6
VI	169	62	36.6	13.2
VII	140	34	24.3	10.8
VIII	163	48	29.4	12.7
Total	1281	364		

2. For Schools C and D Together

Grades	No. Pupils	No. Retard.	Per Cent Retarded	Per Cent in Grades
I	335	143	42.7	22.1
II	243	138	56.8	16.1
III	193	118	61.1	12.7
IV	208	134	64.4	13.7
V	145	103	71.0	9.6
VI	168	104	61.9	11.1
VII	126	78	61.9	8.3
VIII	96	45	46.8	6.3
Total	1514	863		

Table XV shows the situation of retardation by grade for the two sample "American" schools and the two "Latin" schools taken each together. In addition is presented the percentage of the total enrollment found in the various grades. For schools A and B the retardation figures for all the grades but the first run from

22 to slightly above 36 per cent. The largest retardation is found in grades IV, V and VI. In schools C and D together the retardation figures for grades II to VII inclusive is over 50 per cent for each grade and reaches in the fifth the astounding proportions of 71 per cent. The largest figures are shown for grades III, IV, V, VI and VII. In both these schools the duplication of sections for both lower and upper half grades is very much greater than in schools A and B. Not only does retardation clog the school machinery, but the teaching problem is made more difficult. Those who sit two years in the grades are usually those who profit least by the instruction.

Interesting side-light on the problem is shown moreover by scanning the column at the extreme right of the table. For A and B with the exception of the first grade the percentage of pupils of the total enrollment is throughout pretty uniform. Normally if the children were theoretically placed in the grades the percentage for each would lie between 12 and 13. The actual figures from grade II to VIII is from slightly less than 11 to a fraction above 13. For C and D with the one exception of grade VI there is a steady decline in the percentage of pupils from grade I with 22 per cent (over one-fifth of total enrollment) to but a trifle over 6 per cent in the eighth grade. Curiously too, for that grade, the fifth, with the greatest retardation, the percentage of total enrollment is only 9.6 per cent.

The results for these two groups of schools in San Jose are typical not only for San Jose but for the other cities and towns from which the children tested came. In the case of Sunnyvale the school compared more favorably with schools A and B, but in South San Francisco, Milpitas and Half Moon retardation conditions were more serious than in San Jose. Specific retardation reports on these smaller localities are omitted. For Santa Clara, however, certain statistics are available through the work of a former principal there and sample tables from her work are given (85).

Santa Clara has one large public elementary school in size much like school C in San Jose, except that the number of children of North European ancestry is somewhat higher. The economic and social background of the school population is not unlike the similar school population in schools C and D. The following figures are for the upper grades only (the half grades are put together):

TABLE XVI. RETARDATION AND ACCELERATION IN SANTA CLARA, 1917-18 [10]

1. NON-LATINS

Grade	No. in Class	No. Accel.	Amt. Accel.	No. Normal	No. Retard.	Amt. Retard.
IV	32	6	7	17	9	23
V	27	3	6	11	13	39
VI	38	14	18	19	5	10
VII	41	8	11	18	15	37
VIII	38	11	21	16	11	18
Totals	176	42	63	81	53	127

Terms retarded 127
Terms accelerated 63

Retardation 64

2. LATINS

Grade	No. in Class	No. Accel.	Amt. Accel.	No. Normal	No. Retard.	Amt. Retard.
IV	43	3	3	4	36	114
V	42	5	6	4	33	160
VI	20	1	1	5	14	40
VII	15			4	11	25
VIII	4			1	3	4
Total	124	9	10	18	97	343

Terms retarded 343
Terms accelerated 10

Retardation 333

Again the difference between the Latins and the non-Latins is marked. The retardation is progressively greater as one proceeds through the lower grades. The following brief table is culled from Miss Preston's study in attempt to throw light on possible causes of this state of difference between the groups with which the school had to deal.

TABLE XVII. RANGE OF INTELLIGENCE QUOTIENTS OF PUPILS IN CERTAIN GRADES, SANTA CLARA, 1917-18

	Ranges of I. Q.'s in Grades				
Race	IV	V	VI	VII	VIII
Latins	66-108	68- 98	63-104	66-103	71-106
Non-Latins	81-128	61-125	90-154	82-125	75-134

The range of I. Q.'s with which the teachers deal is closely related to the amount of retardation. It is self-apparent that while in both Latin and non-Latin groups the range of intelligence is rather long, that the problem of teaching the American children, in terms of ability, is far easier than with the Latins who in no case rise but a few points above the standard average intelligence which would be expected of children in any given grade.

The following quotation from the study of Miss Preston at Santa Clara typifies the whole matter (85, p. 22):

> Since it is well recognized that no class can make progress faster than the majority comprising it, these figures (some of which were quoted above) show the impossibility of the first, second, third, fourth, and fifth

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[10] Computed on basis of school terms of half-year's duration.

> grades, with a majority below normal, making the progress possible in 1905 when the great majority were normal. . . . Letting the superior (pupils) skip a grade helped a month or so at the time, but as the class they went into was still progressing at what was a snail's pace for them, they again tended to sink back into a state of inertia, losing initiative and forming habits of indolence without developing the power of application and executive ability for which there is so strong a demand in the world's work.

It is obvious that we are dealing with certain classes of South Europeans who come to our shores who present a serious problem not only industrially and politically but educationally. The big bulk of these people are of peasant type: patient, persevering, and mediocre. Is their difficulty in our schools, their lack of educability (for that is what it is) one of language handicap alone, one of difference of cultural heredity or does the principal cause lie in roots over which the environment has little play? In the present study we shall attempt to present further evidence on the possible cause of the educational problem and its implications, and believe that psychological tests and other measures of proficiency will aid in the solution of this perplexing question.

2. MEASURES OF AVERAGES, DISPERSION AND OVERLAPPING

This section deals with the statistical treatment of the data. Since there are two general sets of material,—first, grade-location, teachers' ratings of intelligence and of school work and social-economic status of parents, and second, the results of the mental tests,—it will be convenient to deal at first with each class of data separately.

A. School Success and Teachers' Estimates.

i. Grade Location. The position of any pupil in the scale of grades may be thought of as a common measure of his school success. Table XVIII shows the percentage of the total number of 12-year-old children in the respective grades. The facts of retardation brought out above would lead one to expect that in a group of children of such an age one would find a wide range of grades covered. Since the purpose of this study is to compare three groups of pupils of Latin stock with pupils who are North European (non-Latin) in origin, it will be convenient throughout to use the latter as the point of departure.

TABLE XVIII. PERCENTAGE OF 12-YEAR-OLDS IN VARIOUS GRADES BY RACIAL GROUP

(A)

Grade	American S. J.	Italian S. J.	Spanish-Mexican
I HS	.3		
H 8	.6		
L 8	3.4	.5	
H 7	6.9	2.6	3.8
L 7	24.3	4.1	
H 6	12.0	6.1	9.4
L 6	18.6	16.8	13.2
H 5	11.1	18.3	3.8
L 5	8.9	9.2	16.9
H 4	6.0	9.7	20.7
L 4	3.7	10.7	15.2
H 3	1.8	13.3	7.5
L 3		6.1	1.9
H 2		2.0	5.7
L 2			1.9
H 1		.5	
Total Nos.	316	196	53

(B)

Grade	American Misc.	Italian Misc.	Portuguese
8	3.3		1.3
7	43.3	14.1	9.0
6	34.4	28.0	26.9
5	11.1	24.5	32.0
4	6.6	24.5	21.7
3	1.1	7.0	7.7
2		1.4	1.3
Total Nos.	90	57	78

It is evident at once that the range of grades for the non-Latin group out-reaches that of any of the other groups at the upper end. In the case of the San Jose data, the Italian group has a range of fourteen half grades, the Americans but twelve. The former, however, run from high first grade to and including low eighth grade, the latter reaches from the high third to the freshman high school, inclusive. Inspection of the arrays indicates that there are really two modal locations of the pupils in all three groups. The Americans are located principally in the low seventh and in the low sixth; the Italians in the high fifth and low sixth, and in the high third and the low fourth; the Spanish-Mexicans are located in the low sixth (a comparatively small group) and in the low fourth, high fourth and low fifth. Forty-three per cent of the total number of Spanish-Mexicans are located in these latter three half-grades. Observation of the percentages in Table XVIII shows that the point between the high fifth and the low sixth may be considered as the median for the Spanish and Italian groups combined. Using this as a reference, the figures reveal that 47 per cent of the Americans exceed the low sixth grade level of these Latin groups.

The facts of the second set of data in Table XVIII indicate much the same sort of comparison. Here the data had to be thrown into whole grades which smooths out some of the differences that would be apparent in grouping by half-grades. The modal grade for the Portuguese is the fifth, that for the Misc. American the seventh, while the Misc. Italians are spread fairly evenly over the fourth, fifth and sixth grades, with a slight preponderance in the last. It should be noted that the Misc. Italian and Misc. American groups are very nearly identical with the San Jose Italian and American data respectively.

The facts of grade location, then, would point to decided differences in the Latin and non-Latin groups, a difference on the average of from one and one-half to two grades. It is at once questioned: Is this difference due to the language handicap of the former group, or is it due to difference in mental capacity in the two groups? What light will the teachers' estimates of general intelligence and of school work throw on the possible cause of this, or at least, will there be any general similarity of these measures of ability and education and the standing of the pupils in the grades?

ii. Teachers' Estimates of General Intelligence. Table XIX shows the means, with their S. D.'s, of the teachers' estimates of general intelligence and of school work.[11] The ratings were taken twice and these figures are for the mean of the two. The ratings on the American children seem a little more reliable, as indicated by the P. E. of the means, than those for the Latin groups. One would expect that the teachers would be somewhat more constant in their estimation of the American children. The Latin children are probably a little more favorably looked upon by the teachers than the non-Latins because of over-ageness. It is the common experience of all investigators that the teachers have a decided tendency to over-estimate the intelligenc of these immigrant pupils due to their chronological age. The 12-year-old Italian, for instance, who is in the low fourth grade is large for his age and probably average in school performance, hence the teacher unwittingly rates him as average in intelligence, forgetting that the average 12-year-old is really in the sixth or seventh grade. This subjective factor creeps in constantly in spite of careful instructions, both oral and written, to the contrary. Any rating, of course, is as much a measure of the person making the rating as of the person rated. Furthermore, a rating is really a rank in a class, not an objective measure as we think of them so commonly.[12]

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[11] The estimates were made for both intelligence and school work on the following seven-fold scale:

1—Very Superior.
2—Superior.
3—High Average.
4—Average.
5—Low Average.
6—Inferior.
7—Very Inferior.

In rating intelligence the teachers were instructed to rate the pupil in comparison with all 12-year-olds; in rating school work, to compare him with the average performance of his particular class.

TABLE XIX. AVERAGES AND MEASURES OF DISPERSION IN TEACHERS' ESTIMATES OF INTELLIGENCE AND QUALITY OF SCHOOL WORK

	INTELLIGENCE				SCHOOL WORK			
Race Group	Mean	S.D.M.	P.E.M.	S.D.Dist.	Mean	S.D.M.	P.E.M.	S.D.Dist
American S. J.	3.65	.12	.08	2.15	3.59	.13	.09	2.37
Italian S. J.	4.42	.16	.11	2.22	4.85	.16	.11	2.24
Portuguese	4.66	.23	.16	2.05	4.68	.22	.15	1.89
Spanish-Mexican	4.88	.30	.20	2.48	4.42	.28	.19	2.02
Italian Misc.	4.35	.30	.20	2.28	4.55	.31	.21	2.31
American Misc.	3.90	.20	.14	1.92	3.95	.20	.14	1.91

TABLE XX. DIFFERENCES IN THE MEANS AND THE P. E. OF DIFFERENCES

	INTELLIGENCE		SCHOOL WORK	
Race Groups	Difference in Means *	P. E. of Difference	Difference in Means	P. E. of Difference
American and Italian S. J.	.77	.14	1.26	.14
American and Portuguese	1.01	.18	1.09	.18
American and Spanish-Mexican	1.23	.22	.83	.21
American Misc. and Italian Misc	.45	.24	.60	.25

* All the differences are "less" than the American means.

Table XX shows the differences in the means of the groups in teachers' estimates of intelligence. These reveal in another way that the Italians are nearer the Americans in performance, the Spanish-Mexicans farther away, with the Portuguese between. The P. E.'s of the differences are insignificant where the differences are at all large; where they are small the P. E.'s are large, showing, as is evident, that the difference while small may fluctuate within the limits of the P. E. and yet not be far different than at present. It means practically that the difference is of no importance.

The American groups out-rank the Latins about .8 of one class-rank on the seven-fold scale. Just how much this difference is in terms of objective scores in a given test or in mental age it is difficult to determine. Also whether the units on such a scale are to be considered equal or variable, is unknown. And more difficult to decide is whether in the minds of the teachers, they were so considered. At any rate one may say that roughly the mean difference is about one-eighth of the entire range on the scale of estimation. If the range of grades be represented as eight, then the difference in the mean grade would be approximately one-sixth to one-eighth of the range there. This perhaps gives a crude indication of the comparative likeness of these two measures of the pupils' ability to take on the traditional education offered by the public schools.

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[12] Cf: (17), (111) and (110, pp. 24, 26) on difficulties in objective trait rating by teachers.

TABLE XXI. PERCENTAGE OF PUPILS RECEIVING GIVEN RATINGS IN INTELLIGENCE AND SCHOOL WORK [13]
(Teachers' Estimates)

	RACE GROUPS							
Rating Scale	American S. J.		Italian S. J.		Portuguese		Spanish-Mexican	
	Intell.	Schwk.	Intell.	Schwk.	Intell.	Schwk.	Intell.	Schwk.
1.0	.9	2.8						
1.5	3.0	1.9	.5	1.5	1.9		1.9	
2.0	11.1	7.3	2.6	1.5	1.3	2.6		3.8
2.5	8.5	5.0	3.5	1.0	1.3	1.3	1.9	1.9
3.0	14.2	12.3	5.1	10.2	3.9	2.6	3.8	5.7
3.5	13.2	14.2	10.7	8.1	7.7	5.1	7.5	3.8
4.0	25.3	24.1	24.4	26.0	15.3	25.6	15.2	32.0
4.5	9.4	12.0	11.2	12.8	17.9	21.8	28.3	11.3
5.0	8.5	11.1	20.4	18.3	17.9	25.6	15.2	20.7
5.5	2.8	3.1	9.2	9.7	16.6	6.4	11.3	13.2
6.0	1.6	4.7	8.1	3.1	9.0	3.8	5.7	3.8
6.5	.6	.6	1.0	4.1	6.4		3.8	1.9
7.0	.3	.6	3.1	3.5	2.6	5.1	5.7	1.9

Table XXI gives the percentages in each one-half of class-rank, *i. e.*, on seven-fold scale, for the groups. Here, as in grade location, the American group indicates a skewness toward the upper end of the curve. This may indicate as does the skewness in grade location for age, that the American groups are superior to the average for their age throughout the country at large. It must be constantly borne in mind that the comparison is between the older American stock and the newer immigrant constituency. The mean age-grade location for the total school population must lie somewhere between the two. So with the estimates of native ability, when compared to the "average" child who is in this age-group. In any case, again, there is marked difference in the estimated intelligence of the groups. The Latins falling more closely together, with the Americans out-stripping in the higher ranges, and being not only relatively better off in the latter, but absolutely, for in no case did any Latin pupil receive a mean rating of "Very Superior" in general mental ability, while, on the other hand, the Latin group had a decided percentage in its favor who were considered "Very Inferior."

Whatever be the consensus of opinion as to the validity of the teachers' ratings of pupils (121), the fact remains that it has considerable validity for rough classification and correlational treatment has shown that while it is not so reliable for prognostication as are mental measurements, it is much more so than random subjective impression that this pupil is thus, and that one so.

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[13] This table computed from Tables II, IV, VI, VIII. The figures are based on the mean of two estimates.

The significant matter for the present purpose is the apparent close relation of these estimates to grade location, and the all-around superiority of the American children in the minds of the teachers. While taking into account the likelihood of considerable error in teachers' ratings, the indubitable fact remains that these ratings do show wide differences in the abilities of the groups in question.

iii. Teachers' Estimates of School Work. The ratings on quality of school work were on the same seven-fold scale as the estimates of intelligence. In this case, the teacher was requested to compare the child to be rated with the average child in his grade. Table XXI shows the facts concerning the percentage of each racial group falling in the scale. Again the Americans are much more variable than the Latin groups, but in the case of the C. T. the groups are much farther apart than they are in estimates of intelligence. The mean difference of all the means of the groups for the school work is .94 of the range of one class-interval or class-rank in the scale. This is nearly one-seventh of total range.

Table XX presents the mean differences in the C. T. of the estimates of school work for the several groups. As in the case of rating intelligence there persists a considerable divergence of the Latins from the Americans.

It is also instructive that while 3 per cent of the American group averaged "Very Superior" in the rating of school success, none of the Latin group warranted the same. Yet one must be careful not to overlook the facts that may go to influence any teacher's rating of a child (111, pp. 95, 97). Not only personal factors of appearance, impression and prepossession generally affect the ratings, but also the fact that what may constitute "average" in school work to one teacher may not be so to another.

In the case of school work, as in rating intelligence, the overageness of the immigrant children gives them an advantage with the teachers. The fact that they are retarded in the grades, sitting perhaps a second time in a particular section, is ignored or forgotten when the comparison is with pupils much younger and attacking the school work for the first time. Even these facts do not prevent marked differences in the mean performance at each grade for the common age of 12 years.

TABLE XXII. MEAN TEACHERS' RATING OF SCHOOL WORK FOR EACH GRADE, ALL PUPILS BEING 12-YEAR-OLDS

Grades	H 2	L 3	H 3	L 4	H 4	L 5	H 5	L 6	H 6	L 7	H 7	L 8	H 8	I HS
Amer. S. J.			5.00	4.75	4.71	4.21	4.13	3.68	3.68	3.46	3.27	2.68	*	*
Italian S. J.	5.25	5.00	5.65	4.88	4.70	4.69	4.00	3.91	4.25	3.75	3.10			
Spanish-Mex.	5.34	4.50	4.25	4.87	4.40	4.55	3.25							
		3		4		5		6		7				
Portuguese		5.16		4.67		4.28		4.29		4.57 †				

* Omitted because of too few cases.
† Portuguese in full grades.

Table XXII shows this feature of the matter of school work as related to grade and age factors. Tabulating the 12-year-olds for American and Latin groups by their grade location and then determining the mean of the teacher-ratings of school work for those in the particular grades, one is able to see again that the teachers' estimates are about what one would expect. Not only is the retarded 12-year-old back in his grade location, but he is also retarded in his school ability in the grade in which he is found. The table shows that beginning with the lowest grade in the case of the Italian children, the mean of the average ratings on school work are below the average for that particular grade, but as one goes up the scale toward the grades normally occupied by the 12-year-olds he finds the mean approaching the average for the grade. At the high fifth the Italian seems to be average for his grade, he is slightly better for the low sixth, not so good in high sixth, and again better in the next two half grades. The number of cases is small in high seventh and there is but one case in low eighth. In the case of the Americans much the same thing is observed. The 12-year-old who is in the lower grades is poorer in his class than the much younger but abler pupils even though he has sat in his grade perhaps two or three terms. The Americans rate "average" at about the same point as the Italians (between the high fifth and the low sixth grades). But both the Italians and, more so, the American children, who are in the seventh and eighth grades do better than the average of the class. As the 12-year-olds in the lower grades are much more retarded than the younger children in these grades, so the 12-year-old who is advanced in his grade is also superior to the average of his class.

Like figures are given in the table for the Portuguese and Spanish, but the numbers in the separate classes are rather small. The Portuguese, it will be recalled, are tabulated only in whole grades. But, in general, the same situation holds for these pupils. The 12-year-old who is in the lower grades is poorer in school performance than his class average, although he has had the advantage of additional time, study and teachers' instruction.

B. The Social-Economic Status of the Parents.

The parents' occupations[14] were noted when the tests were given, and were later checked up in doubtful cases through the principal's office. While a somewhat extensive rating scheme has been used for correlational treatment, a simpler scale, that of Taussig (109, pp. 134-8) will be employed here for a brief review of the important facts about the occupational levels of the parents of the children. Taussig outlines five classes of vocations, largely on the basis of economic standing. It is not an attempt to rate the occupations by the amount of intelligence required to make a success of the same. Class I includes the unskilled day laborer; II, the semi-skilled; III, the "aristocracy of the manual laboring class," the skilled workmen; IV, the lower middle class ("the white-collared working class"). "Here are clerks, bookkeepers, salesmen, small tradesmen, foremen, teachers of the lower grades," etc. Class V constitutes the "well-to-do": "those who regard themselves as the highest class." It includes the professionals, the business men, managers of industry, higher public officials and the smaller propertied classes generally. Taussig omits in his classification those of great wealth, on the assumption that they do not constitute an occupational group. Other students have used somewhat different classifications (16, 54, 84) but these are not especially different in general outline from Taussig's.

TABLE XXIII. PERCENTAGE OF PARENTS OF PUPILS IN EACH RACIAL GROUP IN EACH OF THE FIVE CLASSES OF TAUSSIG

	Percentages in Class:				
Race Group	I	II	III	IV	V
American S. J.	5.7	16.1	38.0	31.6	8.6
Italian S. J.	52.0	18.9	16.3	12.8	
Portuguese	43.6	19.2	10.2	26.9	
Spanish-Mexican	39.6	30.2	22.6	7.5	
American Misc.	8.9	13.3	48.9	24.4	5.5
Italian Misc.	35.1	21.1	10.5	33.3	
Average for Americans	7.3	14.7	43.5	28.0	7.0
Average for Latins	42.6	22.7	14.9	20.1	

Table XXIII shows the percentage of the parents of the pupils in each occupational classification. The Latins distribute themselves over the lower four classes. The big bulk of them are in I, II and IV. The fourth class includes not only small shop keepers, but small land holders, and a good many of the Latins in this class come under this occupation. There are relatively fewer of them in the skilled trades. The Spanish-Mexicans run higher in the skilled trades than the Portuguese or Italians. So, too, the Misc. Americans have 10 per cent more in the skilled trades group than the S. J. Americans. On the other hand, the Spanish-Mexicans have but a low percentage in class IV. The Portuguese run up toward the American percentages in class IV, largely because of their property holdings at Half Moon and Milpitas.

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[14] By "parents" is meant the father if living, if not then the mother; if she be deceased, then the guardian.

The most striking feature of this array of percentages is the fact that *none of the Latins* have parents who fall in the upper class. The new-comers into this country from South Europe are not from the professional classes. What one or two generations would indicate in these same families would be interesting to know. The writer ventures a guess that there will result a realignment of groupings, and that these will follow in general lines the innate capacity of the family stocks. Those families possessing good mental ability will produce the offspring who will make use of the educational-professional opportunities about them, in contrast to the lack of such opportunities for professional life in the present generations, which must establish themselves economically in the New World.

Is there any relation between the intelligence of the children and the present occupational groupings of the parents? If the mass of immigrants from the Old World are all at about a common economic level upon arrival here (the writer does not believe they are), has any shifting about in occupational levels taken place in this country which result in classification in groups more commensurate with their mental capacity? Table XXIV indicate a rough answer to this question by showing the mean score in alpha and beta for the four principal samples of racial groups in the five-fold classification. One perceives that there is a scaling off of average score corresponding to the steps of the scheme of classification itself. True, one cannot say that such a ratio is the correct measure of mean intelligence required of the occupation in any case. But it is interesting that such a gradation occurs. The overlapping in alpha and beta between classes is large. Even the performance of beta indicates the fact, although not so markedly as alpha. Other investigators have found very similar relations (2, 16, 84).

TABLE XXIV. MEAN ALPHA AND BETA SCORES PER THE OCCUPATION CLASSIFICATION OF THE RACIAL GROUPS

	Americans S.J.		Italians S.J.		Portuguese		Spanish-Mexicans	
Taussig Scale	Mean A	Mean B	Mean A	Mean B	Mean A	Mean B	Mean A	Mean B
V	83.35	71.10						
IV	67.30	70.35	40.70	68.71	36.60	63.25	39.00	57.00
III	54.75	68.66	36.06	59.75	30.50	57.42	43.00	58.88
II	41.60	64.00	35.92	55.76	29.50	57.62	18.16	52.78
I	48.40	60.70	19.57	49.12	13.30	42.00	21.67	46.22

It is evident that the study is dealing with pupils from families of widely diverging social-economic classes, yet even the "native" American group contains but few in the very highest classification. Neither are there many parents of these children who warrant the term "common, unskilled labor." The principal difference lies in the third and fourth classes of Americans as compared to the first and second for the South Europeans.

The writer desists from entering at this point into a polemic as to the case for inheritance versus environment as the cause of these differences. It is sufficient to note that considerable difference does exist, and must be taken into account in interpreting the total results of the study.[15]

C. Results from the Mental Tests.

The general measures of averages and dispersion have been tabulated into one table (Table XXV), but for matter of convenience the test results had best be dealt with under the separate headings first. Analysis of the individual tests in alpha and beta follow later.

i. The Army Alpha Findings. Inspection of Table XXV reveals striking differences in the performance of these groups of 12-year-olds in the alpha test. The American groups out-reach the best Latin average by double the latter's score. Not only are the differences in the means of the group large, as shown by Table XXVI of the differences in the means with the P. E. of the differences, but the variability of the American groups is greater than that of the Latins. The Misc. American group, however, is not so variable as the S. J. American, although the difference in the means of these two is not large. Table XXVI shows the reliability of the differences in terms of the P. E. of the differences. So far as the Latin and the non-Latin groups are concerned, the differences are all significant and the P. E.'s indicate that the sample data are unselected. The differences between the two American

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[15] Since this was written Arlitt (2) has pointed out the possible effect that economic status may have on the test results of the children of various races. The writer does not deny that economic status may play a part, but certainly, as will be shown subsequently, there is very little correlation between Taussig's classification and the mental status of the groups. Were the two so casually related there ought, it seems, to be considerable correlation between economic status and results in the tests. Inspection of Table XXIV shows that there is no uniformity in the intelligence level of the children of various race groups in the several economic classts; throughout, the scale itself is so general and the lines of ability and skill in reference to intelligence so poorly drawn that no generalization may be drawn from it concerning the influence of environment on mental ability as shown in tests.

TABLE XXV. AVERAGES, MEASURES OF DISPERSION AND PERCENTILES FOR ALL DATA

	Race	No.	Mean	SDm	PEm	SDdt	SDsd	PEsd	PE dt	Mdn	SD mdn	PE mdn	Q	Dp.90-p.10	PERCENTILES													
															.05	.10	.20	.25	.30	.40	.50	.60	.70	.75	.80	.90	.95
ALPHA	Amer. S. J.	314	60.40	1.54	1.04	27.40	1.09	.74	18.48	59.21	2.13	1.44	19.81	73.10	18.50	25.26	35.80	41.21	43.42	49.94	59.21	66.74	76.10	80.82	85.74	98.36	107.81
	Ital. S. J.	191	28.20	1.49	1.01	20.60	1.05	.71	13.90	24.92	2.12	1.43	15.00	50.34	2.05	4.09	8.80	11.03	13.20	18.97	24.92	30.58	37.73	41.02	44.43	54.43	68.58
	Portuguese	77	27.20	2.64	1.78	23.20	1.87	1.26	15.65	22.00	3.13	2.11	15.11	51.34	1.33	2.67	5.83	8.25	10.42	16.50	22.00	27.50	35.25	38.46	47.50	56.00	78.13
	Span.-Mex.	51	25.90	2.66	1.79	19.00	1.88	1.27	12.82	23.67	4.12	2.78	14.47	53.83	1.91	3.84	7.50	9.32	11.42	16.25	23.67	28.33	34.13	38.25	42.50	57.67	63.13
	Ital. Misc.	57	25.45	2.73	1.84	20.60	1.93	1.30	13.89	21.75	2.36	1.59	8.98	42.91	2.14	4.28	11.50	13.88	15.68	18.83	21.75	24.70	30.06	31.84	33.63	47.17	58.13
	Amer. Misc.	88	58.60	2.71	1.83	25.40	1.92	1.30	17.13	61.04	3.52	2.37	17.67	70.91	10.50	21.50	35.10	39.50	45.00	53.83	61.04	67.50	73.90	76.83	80.17	92.41	96.41
BETA	Amer. S. J.	307	68.30	.67	.45	11.75	.48	.32	7.03	68.88	.73	.49	7.59	31.13	47.20	51.89	58.53	60.97	63.10	66.32	68.88	71.34	74.14	75.96	78.22	83.02	86.54
	Ital. S. J.	192	54.00	1.16	.78	16.10	.82	.55	10.90	54.75	1.50	1.01	10.42	41.56	25.03	31.58	39.95	44.75	46.84	50.91	54.75	59.79	63.63	65.58	67.58	73.14	79.25
	Portuguese	75	52.50	1.69	1.14	14.65	1.20	.81	9.88	52.03	2.32	1.56	11.02	39.31	29.13	31.94	39.75	42.09	44.44	48.25	52.03	56.00	61.00	64.13	66.42	71.25	76.00
	Span.-Mex.	53	52.65	2.19	1.48	15.95	1.55	1.05	10.76	52.96	2.39	1.61	11.02	36.83	23.00	35.05	40.50	43.81	45.94	49.25	52.96	56.50	60.25	65.84	67.50	71.88	76.50
	Ital. Misc.	54	54.55	1.79	1.21	13.20	1.27	.86	8.90	54.75	2.63	1.77	10.24	35.63	*	35.75	42.46	44.39	49.84	52.75	54.75	58.17	62.55	64.86	67.04	71.35	74.05
	Amer. Misc.	86	65.95	1.48	1.00	13.75	1.05	.71	9.27	66.67	1.66	1.12	7.82	35.40	40.50	47.35	56.66	58.61	60.39	61.32	66.67	69.95	72.82	74.25	76.31	82.75	88.13
COMBINED ALPHA AND BETA	Amer. S. J.	305	129.45	2.05	1.38	35.80	1.45	.98	24.15	129.23	3.01	2.03	26.98	92.83	69.49	82.25	96.11	102.16	107.79	118.48	129.23	139.75	150.64	156.09	161.92	175.18	187.06
	Ital. S. J.	187	81.55	2.50	1.69	34.20	1.77	1.19	23.07	81.03	3.73	2.56	25.24	87.03	26.22	38.22	49.68	55.15	60.36	70.75	81.03	90.62	100.26	105.65	110.95	125.25	141.92
	Portuguese	74	76.55	4.93	3.33	42.40	3.48	2.35	28.60	73.08	5.86	3.95	27.01	87.19	27.46	38.04	47.75	52.10	56.46	64.86	73.08	83.06	99.31	106.11	112.84	134.15	*
	Span.-Mex.	51	77.95	4.44	2.99	31.20	3.90	2.63	21.04	75.90	6.12	4.13	20.79	85.13	27.50	39.95	50.15	55.25	60.21	68.05	75.90	84.08	92.58	96.83	103.75	126.08	134.58
	Ital. Misc.	54	79.35	4.14	2.79	30.40	2.93	1.98	20.50	76.67	5.52	3.72	18.68	75.85	*	42.30	52.11	57.02	61.44	69.90	76.67	85.25	92.00	94.38	98.75	118.15	142.75
	Amer. Misc.	84	127.25	3.75	2.53	34.40	2.66	1.79	23.20	128.45	5.29	3.57	23.19	91.02	60.55	77.35	97.08	104.04	110.04	121.14	128.45	135.75	146.15	150.42	156.02	168.37	174.83

* Impossible to compute.

groups and the two Italian groups are negligible, as shown by the size of the P. E. of these differences as compared with the actual value.

TABLE XXVI. DIFFERENCES IN THE MEANS AND MEDIANS IN ALPHA AND BETA TOTAL SCORES WITH P. E.'s OF DIFFERENCES

	ALPHA		BETA		COMB. A. & B.	
Difference between	M.	Mdn.	M.	Mdn.	M.	Mdn.
American S. J. and Italian S. J.	32.20	34.29	14.30	14.13	49.90	48.20
P. E. difference	1.45	2.03	.9	1.12	2.18	3.27
Difference between American S. J. and Portuguese	33.20	37.21	15.80	16.85	52.90	56.15
P. E. difference	2.06	2.55	1.22	1.63	3.60	4.44
Difference between American S. J. and Span.-Mex.	34.50	35.54	15.65	15.92	52.50	53.33
P. E. difference	2.07	3.13	1.55	1.68	3.29	4.60
Difference between Amer. S. J. and Misc. Amer.	1.80	1.83*	2.35	2.21	2.20	.78
P. E. difference	2.10	2.77	1.10	1.22	2.88	4.11
Difference between Italian S. J. and Misc. Italian	2.75	3.17	.55†	.00	2.20	4.56
P. E. difference	2.10	2.14	1.44	2.04	3.26	4.52

* The Misc. American group exceeded the S. J. American.

† The Misc. Italian group exceeded the S. J. Italian. All other differences are in favor of the S. J. groups—American or Italian.

Table XXV gives the S. D., Q. and D.[16] as measures of the variability of the groups. The P. E. for the S. D. has been calculated and these indicate throughout the high reliability of the same. The S. J. American group and the S. J. Italian groups are throughout the most comparable; not only are the samples larger, but are probably much less selected. On the other hand, considering the size of the Portuguese and Spanish-Mexican groups, their measures of dispersion, as well as those of C. T., are very reliable.

One observes at once that the data really fall into two groups: the American children on the one hand, and the children of the Latin immigration on the other. It will be more and more evident that on the whole the latter might have been treated as one group without altering the significance of the differences to any extent.

The question naturally arises: How do these groups compare with the performance of the average 12-year-old in the school population generally? This query may be answered by comparing various percentile grades with the age-norms for army alpha. There are two age-norms for alpha,—the first determined in the army itself (141) and the second a combination of norms determined separately by Kohs and Proctor. The norms are both stated in terms of Stanford-Binet Mental Age. In the following table the pertinent comparisons are made:

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[16] Cf: (58) for discussion of D.

TABLE XXVII. STANDING OF 12-YEAR-OLDS WHEN COMPARED TO THE MENTAL AGE NORMS FOR THE ARMY ALPHA TEST[17]

	Upper 75 % Exceeds MA for the		Upper 50 % Exceeds MA for the		Upper 25 % Exceeds MA for the	
Race Group	K-P Norms	Army Norms	K-P Norms	Army Norms	K-P Norms	Army Norms
American S. J.	11-8	12-6	12-8	13-9	14-4	15-3
Italian S. J.	9-8	10-0	10-8	11-6	11-9	12-6
Portuguese	9-6	9-9	10-6	11-3	11-6	12-4
Spanish-Mexican	9-6	9-9	10-6	11-3	11-6	12-4
Italian Misc.	9-9	10-4	10-6	11-3	11-0	12-0
American Misc.	11-6	12-4	13-0	14-0	14-0	15-0

It is noticeable that the American group is practically normal for its age, or slightly in excess, whereas the Latin groups all fall from one to two years below. On the average about 25 per cent of the Latins exceed the norm for their chronological age. Inspection of this table reveals the fact that the norms for the army were slightly lower than those for the school children calculated by Kohs and Proctor. The Latin groups compare somewhat more favorably with the Americans when measured against the army norms. It is likely, especially in the ages 13 and above, that both Kohs and Proctor were working with rather selected samples, since so many boys, at least, in these ages are neither in the elementary nor the high schools. And it is well-known that, on the whole, the mentally retarded are the first to withdraw from school.

It is once more evident that the Latin groups do not reach the normal performance that the American groups do. In grade location they are one to two years behind their competitors, in school work likewise, in teachers' estimates of their intelligence also, and here in the actual findings of the tests, much the same thing is shown.

ii. The Army Beta Results. The second section of Table XXV gives a summary of the principal measures of averages and of dispersion for the beta tests. The differences in the measures of C. T. are again in favor of the American groups. While the differences in means are not so great as with alpha, it must be recalled that the score-range of beta is about half that of alpha. Further, as will be noted later, there are probably differences in the nature of the two tests that need be taken into account in interpreting the differences. The P. E.'s of the means and of the medians show that these are very stable measures for this age-group in terms of the test. While the P. E.'s for the Portuguese and Spanish-Mexican children are larger, they nevertheless are so small as compared to the C. T. that the latter are within narrow limits the true measures. The size of the sample is largely responsible for the greater P. E. with these two groups, for the P. E. of the Misc. American and Misc. Italian groups is relatively the same as that for the Portuguese and Spanish-Mexican classes. Table XXVI shows the differences in the means of the beta results, with the P. E.'s of the differences. These serve as another check upon the extent to which the observed differences fall within the true probabilities. The means seem a trifle better measure of C. T. and of difference than the medians, but on the whole, the median beta is somewhat more stable as a measure of C. T. for this test than is the median alpha for alpha. In beta, as in alpha, the differences between the S. J. American and the Misc. American groups is insignificant. For the two Italian groups, the medians for beta coincide.

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[17] Estimated from percentiles. Fractions less than ¼ year ignored. K-P refers to Kohs-Proctor. These latter norms were worked out by W. M. Proctor and S. C. Kohs at Stanford during the year 1918-19. These norms are obtainable from Dr. Terman at Stanford.

Considering the matter of variability, the results of beta indicate that the American groups are not so variable as the Latins. The S. J. Americans in particular seem to be less variable than the Misc. Americans, the latter coming within practically the same S. D. as the Misc. Italians. The S. D., the Q. and the D. all indicate that the S. J. American group is much more homogeneous in performance in the beta test than in the alpha. Reasons for this will appear subsequently. It may be said that the difference is not extreme, not nearly so much so as is the comparative variability of the Latins and the non-Latins in alpha.

There are no norms available of the beta applied to school children, but the following table gives the comparison with the mental age ratings for beta in the army:

TABLE XXVIII. STANDING OF 12-YEAR-OLDS WHEN COMPARED TO THE MENTAL AGE NORMS FOR THE ARMY BETA TEST [18]

Race Group	Upper 75% Exceeds the MA Norm of Army	Upper 50% Exceeds the MA Norm of Army	Upper 25% Exceeds the MA Norm of Army
American S. J.	12-8	13-8	14-6
Italian S. J.	11-4	12-0	13-4
Portuguese	11-0	12-0	13-0
Spanish-Mexican	11-3	12-0	13-3
Italian Misc.	11-4	12-0	13-4
American Misc.	12-6	13-6	14-4

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[18] Estimated from array of percentiles. Fractions less than ¼ year MA ignored. Cf: (141, p. 133).

Here it appears that compared with the men in the army from whom the beta norms were determined, the Latin groups are practically normal for their chronological age in the test performance. The American groups, however, again outstrip them by a year and a half, which would seem to indicate that were norms worked out on the average American school population they would exceed the norms for the army groups as do similar school norms for alpha. It is furthermore difficult to tell whether the beta in the low scores is comparable to the Binet. There is some evidence that it is not so reliable when compared to Stanford-Binet as the alpha.[19] It is also of little value in discriminating differences in mental levels in the upper ranges of intelligence. Were the test better able to differentiate general intelligence above the 12-year norm, the American groups would in all likelihood outstrip the Latins more than they did. Still further, these norms are not corrected for reliability and the reliability coefficient of the beta is somewhat less than that of alpha. At any rate, the important feature is the superiority of the Americans even in this test in which they are at a disadvantage.

iii. The Combined Army Alpha and Beta Results. The last section of Table XXV shows the averages and measures of variability for the children of the six groups when alpha and beta scores are combined. While this, in a sense, is a mere summation of the two tests, it serves as a better measure of the mental performance of the groups than either test singly. Although it may be questioned whether for practical school purposes a test need be as long as the combined alpha and beta, or that the half of it need be performance, yet it is true that the two scales together give a little more complete "clinical" picture of the behavior of the groups in responding to the tests. Of course, with certain limitations on the efficacy of the tests,—the alpha being somewhat too difficult for the 12-year-old Latins in the lower grades, and the beta not discriminating enough for the non-Latins in the upper grades,—it follows that the combination of the two tends to wipe out this difference, and make the Latin and the non-Latin groups somewhat nearer together.

The reliability of the means and of the medians for the combined tests is very high. These two measures of C. T. are much more nearly equal than they were for alpha or beta alone. This may be another way of noting the general smoothing of the divergence due to the summation of the two batteries of tests. Table XXVI indicates the comparative differences in means and medians. The Italians come slightly nearer the Americans than the other two Latin groups, but as in other measures the three Latin classes are for all practical purposes on much the same level of performance.

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[19] (73) pt. II: ch. 7: pp. 386, 387-8, 394-5.

In summary of the findings on the differences in the C. T. of these groups with these tests, one notes that the differences in the means of the alpha in the case of the S. J. Italians and the S. J. Americans is roughly one-seventh of the total range of the test, the differences in these groups for beta is one-eighth of the range for the beta test, and in the case of the two tests combined as one battery (using the same scoring as when separate) the difference is between one-seventh and one-eighth of the range of the combined batteries. The differences between the American groups and the other two Latin groups is nearly the same, being slightly greater for the Portuguese and the Spanish-Mexican when compared with the S. J. Americans: about one-sixth of the range for alpha, one-eighth for beta, and one-sixth for combined alpha and beta.

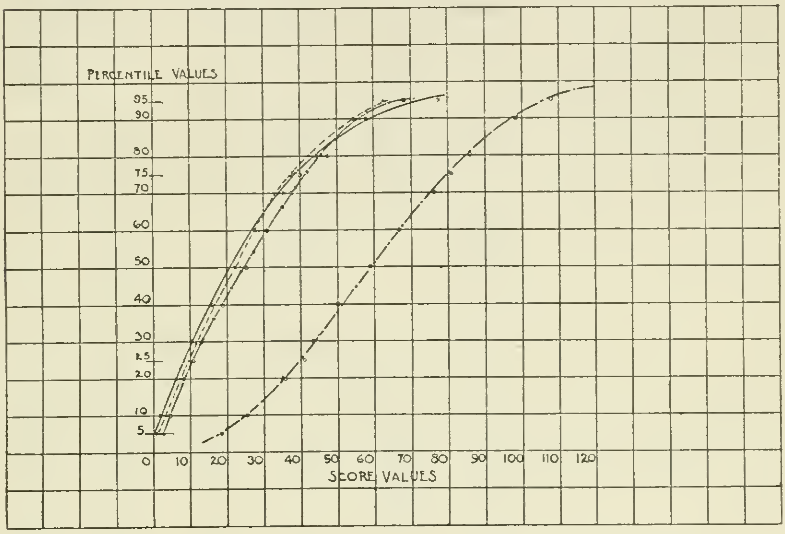
Recalling that the difference in the C. T. of the teachers' estimates of school work and of intelligence were between one-sixth and one-eighth of the range of the scales used, and likewise for the difference in grade location, one must conclude that the whole evidence points to significant differences in these groups by about the amounts found in these several measures of educability and mentality.

D. The Measurement of Overlapping.

Not only are the differences in C. T. important but the total amount of overlapping in the distribution of scores of the several groups is even more so. Especially in treating racial differences and in the determination of the proper classification of pupils in school and analogous situations, it is important to know to what extent any given measure in one distribution reaches or exceeds or is identical with a similar measure in another distribution. The fact of overlapping in school ability in pupils has been investigated (63), but only recently has Kelley (57) shown that the true overlapping can only be determined when the reliability of one's measures is known.

The coefficient of reliability determined by using Brown's formula[20] for alpha was .91, the same for beta was .81. Using Kelley's formula, which requires the coefficients of reliability, the measures of true overlapping were determined. Table XXIX shows the extent of overlapping, noting first the percentage of Latins that exceed the lower quartile, the median, and the upper quartile of the S. J. American group; second is shown the per-

GRAPH I. CURVE OF OVERLAPPING ON ALPHA SCORES—Actual Data.



Legend: Data from Table XXV.

——————————: Portuguese.
—·——·——·——: S. J. Italian.
— — — — — — — : Spanish-Mexican.
—— - —— - ——: S. J. American.

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[20] Brown's formula: Coeff. of rel. $\frac{2r}{1+r}$ is well known (cf: 20).

The determination of the reliability of the tests by this method was somewhat difficult. Two comparable forms of alpha were not given to the same children, and there was but one form of beta. Two methods were open: one was to select alternative items in the various tests of A and B tests, but at Dr. Kelley's suggestion this method was abandoned. In place of that an attempt was made to split each battery into two comparable halves and correlate one half against the other. Two approaches in the choice of comparable halves was used: (1) It is assumed in educational psychology that two tests that correlate very highly with each other are testing the same functions. Those tests that inter-correlated most highly were placed in separate halves of the tests to be correlated by Brown's formula. As a check upon this the judgments of ten competent psychologists from the largest universities of the country as to which tests tended to test the same mental functions were averaged and on the basis of the tendency of these averages to approach each other in magnitude, that is, in terms of the paired tests (being scaled oc as like or unlike in testing functions, in terms of a scale), they were put into the separate compartments. The agreement between the reuslts from this method and the other was very striking. In case of doubt the army inter-correlations were taken as more reliable. The tests finally selected were for alpha: tests 1, 2, 5, 7 to be correlated against 3, 4, 6, 8. In Beta: tests 1, 2, 3, 5 against 4, 6, 7.

The material on judgments of the psychologists was secured from the personal files of Dr. Terman. The army data was from the Memoirs (73, p. 634).

centage of S. J. American scores exceeding the three quartiles for the various Latin groups. In order to indicate the extent to which the correction by Kelley's formula differs from the overlapping in the actual measures, the percentages exceeding the same quartiles are given when computed from the actual distribution.

TABLE XXIX (A). PERCENTAGE OF THE FOLLOWING RACIAL GROUPS EXCEEDING THE S. J. AMERICANS—ACTUAL AND TRUE OVERLAPPING

Race Group	% Exceed. Amer. Q1		% Exceed. Amer. Mdn.		% Exceed. Amer. Q3	
	(Actual)	(True)	(Actual)	(True)	(Actual)	(True)[21]
ALPHA TESTS						
Italian S. J.	24.50	22.66	7.00	4.95	1.00	.55
Portuguese	22.50	23.88	10.00	6.55	2.00	1.07
Spanish-Mexican	21.50	17.36	6.80	2.81	.75	.20
American Misc.		74.22		47.21		21.19
BETA TESTS						
Italian S. J.	33.40	31.21	18.00	16.11	8.25	6.94
Portuguese	29.00	25.46	13.75	11.51	4.15	4.09
Spanish-Mexican	30.40	27.76	15.50	13.79	6.40	5.59
American Misc.		65.17		42.47		22.06
COMBINED ALPHA AND PETA						
Italian S. J.	27.80		8.50		1.00	
Portuguese	26.00		11.30		3.50	
Spanish-Mexican	21.35		7.25		1.75	

(B) LIKE PERCENTAGE OF AMERICANS EXCEEDING THESE MEASURES IN THE SOUTH EUROPEANS

	Q 1		Mdn.		Q 3	
ALPHA TEST						
Italian S. J.	97.00	95.91	90.00	89.25	72.75	76.73
Portuguese	98.00	95.99	92.00	87.97	76.25	78.81
Spanish-Mexican	98.00	96.33	90.50	90.83	76.25	80.51
BETA TEST						
Italian S. J.	96.75	98.87	86.25	91.15	62.00	66.64
Portuguese	97.75	99.01	89.00	93.19	60.75	74.22
Spanish-Mexican	77.00	99.18	90.00	93.06	66.00	71.23
COMBINED ALPHA AND BETA						
Italian S. J.	98.25		90.00		71.55	
Portuguese	98.75		93.25		71.25	
Spanish-Mexican	98.25		92.25		79.00	

Graphs I, II and III show the overlapping of the actual percentile grades in the several groups, determined graphically.[21] Table XXIX gives the true overlapping determined by the use of Kelley's formula. The first part of this tabulation shows the percentage of each of the three groups, S. J. Italians, Portuguese, and Spanish-Mexican, exceeding the medians, and the upper and lower quartiles of the S. J. American. The Misc. Italians are compared with the S. J. Italians to indicate the likeness of these two groups to each other. The same is done for the Misc. Americans and the

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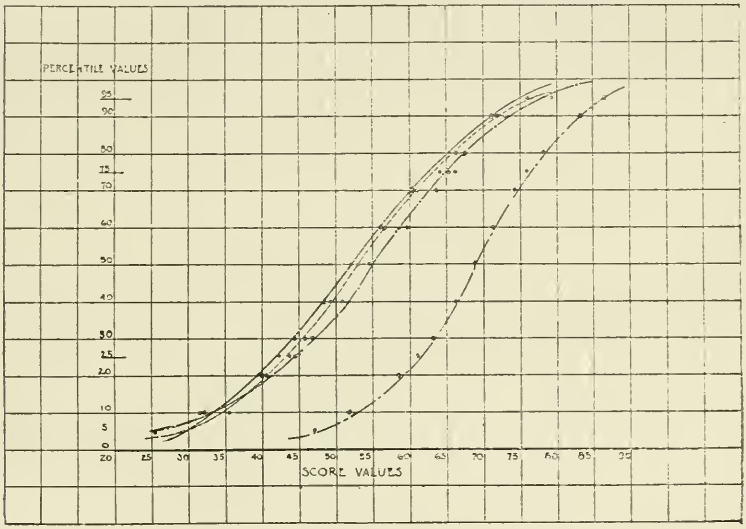
[21] "Actual" overlapping from data at found. "True" camputed using coefficients of reliability of alpha and of beta. The Misc. American group was not used in getting actual data. The "actual" overlapping was determined graphically. Cf: Bowley (14).

S. J. Americans. It is evident that the true overlapping is less than that revealed by the actual results. Only 23 per cent of the S. J. Italians exceed the lower quartile of the S. J. Americans in alpha, but 24 per cent of the Portuguese and slightly over 17 per cent of the Spanish-Mexicans. The overlapping of the median is between 5 and 6 per cent for the first two groups and but 2.81 per cent for the last. And but 1 per cent of the Italians exceed the point reached and exceeded by the upper 25 per cent of S. J. American children. The Portuguese fare a bit better in this comparison but the Spanish-Mexicans worse.

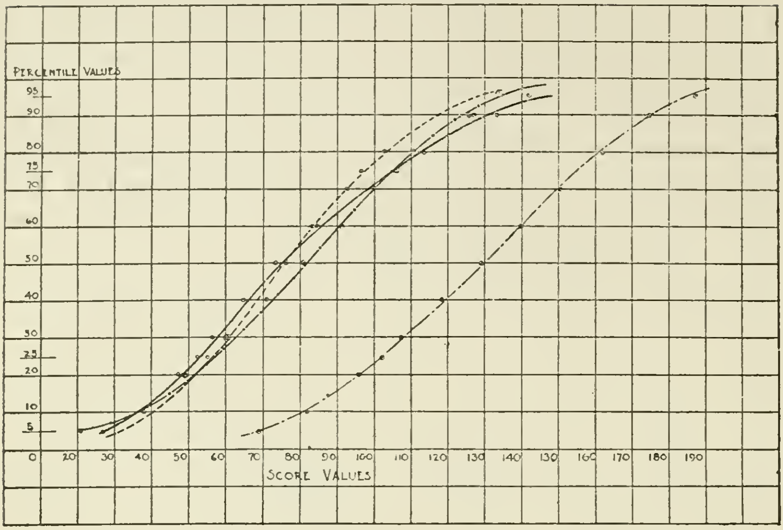
GRAPH II. CURVE OF OVERLAPPING ON BETA SCORES—Actual Data.



(Legend: as in Graph I)

The overlapping in beta examination, while not nearly so marked as in the case of alpha, is still significant. The S. J. Italian group as elsewhere is nearer the S. J. American group in every case, while the Spanish-Mexicans do a little better with beta than the Portuguese. The differences between the Latin groups is in no case marked. But 16 per cent of the S. J. Italians exceed the median score of the S. J. Americans, and hardly 7 per cent exceed the upper quartile. With the other Latin groups still less favorably situated in reference to the "native" American groups, there can be little question of great differences in mental abilities of the groups.

GRAPH III. CURVE OF OVERLAPPING ON COMBINED ALPHA AND BETA SCORES—Actual Data.



(Legend: as in Graph I)

The actual overlapping of the results, using the two tests, alpha and beta, together as one combined rating is practically mid-way between the overlapping in the two separate batteries of tests, but more nearly comparable to that in alpha than in beta.

For comparative purposes the overlapping of the Misc. American group on the S. J. American group is given. The S. J. Americans have a slight advantage but nothing significant. The importance in fact of the nearness of these two groups of Americans is simply to prove that the San Jose children of North European stock are not unlike other "native" American stocks in neighboring California localities. The Misc. Italians compared with the S. J. Italians show that the former are slightly better in the lower half of the scores, but in the beta that the latter have some advantage in the upper ranges of the test results. In the alpha, the S. J. Italians excel their countrymen outside San Jose about as much as the S. J. Americans do the Misc. Americans. In the alpha the S. J. Italians are slightly more variable, but in beta the two groups are very nearly identical. With the Americans the group outside San Jose is a trifle more variable than those from San Jose in alpha and beta both, although the latter group has a somewhat higher C. T.

E. An Analysis of the Individual Alpha and Beta Tests.

i. The Alpha Tests. No attempt will be made here to analyze the statistical problem of the make-up of the battery of tests that comprise alpha. This has been done elsewhere (73, p. 573ff.). Rather a brief review will be made of the standing of the racial groups in the separate tests, and then a presentation of a profile based on the average performance of each group in each test.

TABLE XXX. THE MEAN AND MEASURES OF DISPERSION OF THE SEPARATE TESTS IN ALPHA AND BETA (Four Principal Samples)

	Alpha	M	SDm	PEm	S D dist	P E dist	% M is of Max. Score	% Zero Scores	Beta	M	SDm	PEm	S D dist	P E dist	% M is of Max. Score	% Zero Scores
AMERICAN S. J.	I	5.45	.14	.09	2.55	1.72	45.41	1.3	I	3.34	.05	.03	.88	.59	68.80	.7
	II	5.80	.15	.10	2.59	1.75	29.00	1.0	II	7.15	.19	.13	3.19	2.15	44.68	1.9
	III	6.45	.16	.11	2.87	1.94	40.31	6.4	III	9.94	.09	.06	1.62	1.09	82.83	0
	IV	7.62	.19	.13	3.39	2.29	19.05	19.1	IV	13.31	.05	.03	.80	.54	44.36	0
	V	6.64	.25	.17	4.45	3.00	27.65	10.5	V	13.42	.05	.03	.89	.60	53.68	.7
	VI	5.65	.18	.12	3.21	2.17	28.25	7.3	VI	12.63	.18	.12	3.12	2.10	63.15	0
	VII	8.46	.08	.05	1.47	.99	21.15	8.6	VII	5.23	.14	.09	2.44	1.65	52.30	1.6
	VIII	12.87	.07	.05	1.21	.72	32.18	1.3								
ITALIAN S. J.	I	2.66	.16	.11	2.20	1.48	22.16	20.9	I	2.73	.09	.06	1.28	.86	54.60	8.8
	II	3.48	.18	.12	2.49	1.68	17.40	11.4	II	5.04	.29	.20	3.87	2.61	31.50	14.1
	III	3.31	.20	.14	2.75	1.85	20.68	22.5	III	8.53	.18	.12	2.43	1.64	71.06	.5
	IV	2.61	.27	.18	3.77	2.54	6.52	48.1	IV	12.05	.18	.12	2.50	1.69	40.16	4.7
	V	3.20	.24	.16	3.28	2.12	13.33	33.5	V	14.23	.34	.23	4.80	3.24	56.92	2.6
	VI	2.74	.19	.13	2.64	1.78	13.70	31.4	VI	8.88	.25	.17	3.42	2.31	44.40	.5
	VII	4.18	.35	.24	4.80	3.24	10.45	30.3	VII	3.08	.16	.11	2.16	1.36	30.80	17.2
	VIII	5.57	.37	.25	5.05	3.41	13.92	19.3								
PORTUGUESE	I	2.39	.27	.18	2.35	1.59	19.91	26.3	I	3.15	.13	.09	1.15	.78	63.00	5.4
	II	2.89	.28	.19	2.41	1.63	14.45	6.6	II	4.73	.36	.24	3.06	2.06	29.56	5.4
	III	2.14	.33	.22	2.79	1.88	13.37	39.4	III	7.91	.33	.15	2.83	1.61	65.91	2.7
	IV	1.82	.41	.28	3.56	1.73	4.50	67.1	IV	10.89	.34	.23	2.90	1.96	36.30	5.4
	V	3.08	.40	.27	3.49	2.35	12.83	32.9	V	13.24	.38	.39	4.96	3.35	52.56	2.7
	VI	3.13	.34	.23	2.87	1.94	15.65	23.6	VI	9.35	.36	.24	3.12	2.10	46.75	2.7
	VII	6.43	.66	.44	5.73	3.86	16.07	34.2	VII	2.92	.23	.15	1.94	1.31	29.20	12.1
	VIII	6.01	.63	.42	5.47	3.69	15.02	17.1								
SPANISH-MEXICAN	I	2.45	.27	.18	1.93	1.30	20.31	21.5	I	3.04	.15	.10	1.06	.71	60.80	1.9
	II	2.78	.29	.19	2.05	1.38	13.90	13.7	II	5.89	.43	.29	3.15	2.12	36.81	3.8
	III	2.92	.31	.21	2.23	1.50	18.25	29.4	III	8.42	.32	.22	2.33	1.57	70.16	1.9
	IV	2.45	.51	.34	3.64	2.46	6.12	58.8	IV	11.07	.32	.22	2.34	1.58	36.90	3.8
	V	2.94	.47	.32	3.35	2.26	12.25	41.1	V	12.28	.66	.45	4.84	3.26	49.12	3.8
	VI	3.20	.37	.25	2.64	1.78	16.00	19.6	VI	10.72	.54	.36	3.84	2.59	53.60	0
	VII	3.75	.71	.48	5.04	3.40	9.37	41.1	VII	2.83	.30	.20	2.18	1.47	28.30	13.2
	VIII	5.33	.63	.43	4.52	3.05	13.32	17.6								

Table XXX summarizes the principal data on the averages and measures of dispersion for the individual tests in the four principal groups.[22] There are given the means of each test, with the S. D. and P. E. of the means (as an indication of their reliability), and also the S. D. and P.E. of the distribution of scores in each test. The S. J. American group did decidedly better throughout the entire eight tests. Tests IV and V proved particularly difficult for the Latin groups. The S. D.'s for each of the

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[22] The Misc. American and Misc. Italian groups are so nearly like the larger samples of these same racial groups that they are omitted here.

Latin groups indicate that the spread of the test results downward ran apparently to negative scores. The facts are these: Column 8 of the table gives the percentage of zero scores in each test. It is seen at a glance that the amount of zero grades is very high for these two tests for all the Latin groups. In computing the means, and measures of dispersion, zero scores are counted as a class in the arrays, and hence are actually considered as units on the scale. As is pointed out in the treatise on the statistical interpretation of the army data on alpha and beta (73, p. 622):

> The alpha examination itself is not a homogeneous scale, but a composite of eight short scales, each much more nearly homogeneous than the composite total alpha. . . . Certain of its component tests are very much more difficult than others, so that examinees of less than average intelligence do not in general register their ability in all of the tests. . . . [Since the time allowed is constant for all, some fail to score at all in certain tests, whereas more time might give them a small score] . . . It follows from what has just been stated that subjects who are able to score in all of the alpha tests obtain total scores that are not comparable with the total scores earned by individuals who failed in some of the tests. The reason for this difference is that in obtaining an individual's total score by adding together the scores in each test, scores of 0 are treated arithmetically the same as other scores. There are psychological reasons, however, why 0 as a score cannot be regarded as a point on a linear scale, although other scores can be so regarded. This distinction between the mathematical zero and "psychological" zero is an important one, for failure to recognize it is a serious pitfall in the statistical analysis of psychological data. Zero as a test score means some unmeasured amount of ability that is less than the amount required to earn a score of one point. Thus, if a high degree of ability is necessary to earn a score of one point in a certain test, it is obvious that the range of ability covered by the zero scores is a very wide one, although the ranges corresponding to scores of one point, two points, etc., may be very short. *A score of zero therefore does not mean no ability at all;* it does not mean the point of discontinuance of the thing measured; it means the point of discontinuance of the instrument of measurement,—the test.

It may be said, then, had the alpha test been more adequate for the testing of mentality of unselected 12-year-old children, even of Latin stock, the total scores would have been correspondingly higher, since the percentage of zero scores in tests IV and V, had they been easier, *i. e.*, more adequate to the mentality of the groups, would have been relatively less.

It may be imagined at first glance that since these two tests are particularly language tests, the Latin groups were greatly handicapped by them. While this may be so, in part, the fact that nearly 20 per cent of the Americans scored zero on test IV and over 10 per cent, zero on test V, points to the alternative explanation, that the test is really too difficult for the 12-year-olds, even of normal intelligence.[23] Test VII, which also gave a considerable percentage of zero scores for the groups, is likewise a language test but the Latins did better with it because it permits of differential making of scores by the pupils. In short, however, the penalization of the total score for the Latins as compared to the non-Latins was a matter of relative degree. We may take it that this relative degree is expressed in terms of the difference in the intelligence quotients of the two groups.

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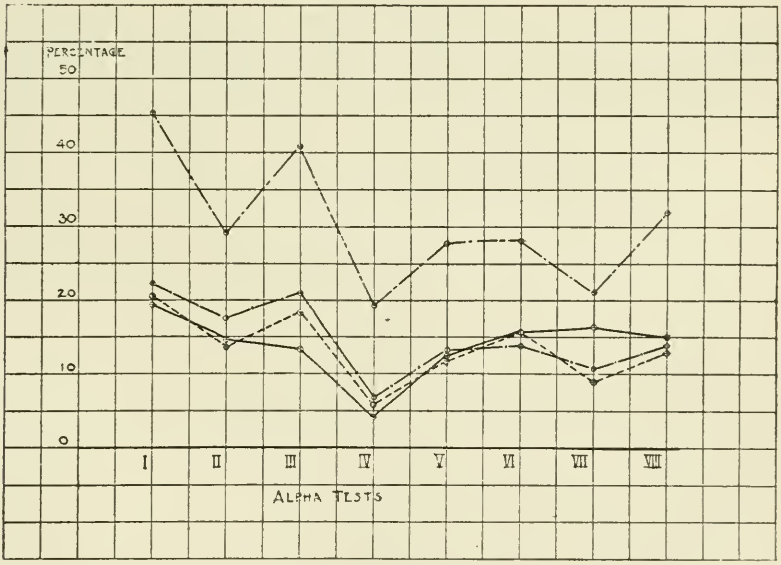
[23] Tests IV, V, VI proved too difficult (as measured by percentage of zero grades) for the draftees and enlisted men in the army. Cf: 73, pt. III: Ch. 2: 624, 626.

In regard, then, to the S. D.'s of the distributions in tests IV, V and VII, it is clear that they are larger than the means simply because their dispersion is represented by a particular portion of the zero scores at the lower end of the scale. For the Spanish-Mexican group, test VI also proved considerably too difficult. In this case, language explanation apparently did not enter in, for the other Latins did decidedly better in VI. It must have been a lack of capacity.

GRAPH IV. PROFILES SHOWING THE PERCENTAGE WHICH THE MEAN OF EACH TEST IS OF THE MAXIMUM POSSIBLE SCORE IN EACH TEST FOR ALPHA



(Legend as in Graph I)

To show the relation of the groups to each other in each test, the percentage that the mean of a given test is of the total maximum score possible of that test was computed throughout the eight tests. These figures are given in Table XXX, and are presented graphically (Graph IV). Observation of these curves reveals certain features in the performance in the test that may be thought typical. As has been observed already, the three Latin samples keep nearly parallel to each other everywhere, in test results and grade location. One of the outstanding aspects of these curves is their general similarity in contour. They rise and fall together in almost every instance. The one exception appears to be with the Portuguese in test VII where they out-distance the other South Europeans somewhat noticeably. The only explanation for this is the possible clue that in the Portuguese group were a few individuals who ran far beyond the average of the group in the alpha test.[24] Had the sample in this case been larger, this exception might be wiped out by the existence of relatively more cases in the lower ranges.

In test I, dependent on language only for the bare directions, the Latins did best of all, yet so did the Americans. In test II (arithmetical reasoning), test III (common sense judgments), and test VI (series completion), the Latins did not do particularly better, relatively, than they did in the tests more obviously dependent on mastery of language. One must keep in mind the fluctuation of the curve for the American group, where the alleged language difficulty does not exist, in order to generalize about asserted linguistic handicaps for the Latins. As noted above, in test IV both Latins and non-Latins fall down. In test V they are comparatively in much the same position with the total sweep of their curves. In test VII it would actually seem that the American group did relatively poorer compared to their total showing than the Latins.

Tables XXXI, XXXII and XXXIII summarize the principal data on the differences in the means of the tests, the differences in percentages of the maximum possible scores for the individual tests and so the differences in the percentages of zero scores for the four groups. In no case is the P. E. of the differences of the means large enough to warrant any other conclusion than that the differences are true differences, and the existence in two or three tests of high percentages of zero scores is after all relative to the groups tested in large part. The array of differences in percentages that the means are of the maximum scores simply states what is pictured in Graph IV. The differences in the percentage of zero scores shows the inadequacy of the test to differentiate at the lower levels of mental ability. The significant thing, then, is that the percentages of zero scores, like the differences in means, either of total or of individual tests, is relative to the mental capacity of the groups in question. While the alpha test did prove at fault in the matter of differentation in the lower ranges, it was a fault that applied equally to all the samples concerned. The average difference in the amount of percentage of zero scores is itself a rough measure of the differences in the mental capacity of the groups.

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[24] Cf: Table VII for distribution of Portuguese. There were five of these pupils with alpha total scores of 99, 92, 89, 84 and 80. Of these, 23, 10, 15, 27 and 17 per cent respectively of the total score came from the score in test VII.

TABLE XXXI. DIFFERENCES IN THE MEANS OF EACH SEPARATE TEST WITH P. E.'s OF THE DIFFERENCES IN MEANS

ALPHA TESTS

Difference in Means—	I	II	III	IV	V	VI	VII	VIII
American S. J. and Italian S. J.	2.79	2.32	3.14	5.01	3.44	2.91	4.28	7.30
P. E. difference	.14	.15	.17	.24	.22	.17	.25	.26
American S. J. and Portuguese	3.06	2.91	4.31	5.80	3.56	2.56	2.03	6.86
P. E. difference	.20	.22	.25	.22	.32	.26	.44	.42
American S. J. and Span.-Mex.	3.00	3.02	3.53	5.17	3.70	2.45	4.71	7.54
P. E. difference	.20	.21	.24	.17	.17	.28	.48	.44

BETA TESTS

Difference in Means—	I	II	III	IV	V	VI	VII
American S. J. and Italian S. J.	.61	2.11	1.41	1.26	.81*	3.75	2.15
P. E. difference	.07	.24	.42	.13	.24	.21	.14
American S. J. and Portuguese	.18	2.42	2.03	2.42	.18	3.28	2.31
P. E. difference	.10	.27	.16	.23	.39	.27	.17
American S. J. and Span.-Mex.	.30	1.26	1.52	2.24	1.14	1.91	2.40
P. E. difference	.10	.32	.23	.22	.45	.38	.22

* The S. J. Italians exceeded the S. J. Americans in this test. All other cases show Americans exceeding the Latins.

TABLE XXXII. DIFFERENCES IN PERCENTAGE THE MEAN OF EACH SEPARATE TEST IS OF THE MAXIMUM SCORE SCORE POSSIBLE IN EACH TEST

ALPHA TESTS*

Difference in %—	I	II	III	IV	V	VI	VII	VIII
American S. J. and Italian S. J.	23.25	11.60	19.63	12.53	14.32	14.55	10.70	18.26
American S. J. and Portuguese	25.50	14.55	26.94	14.55	14.82	12.60	5.08	17.16
American S. J. and Span.-Mex.	25.10	15.10	22.06	12.93	15.40	12.25	11.78	18.86

BETA TESTS

Difference in %—	I	II	III	IV	V	VI	VII
American S. J. and Italian S. J.	14.20	13.18	11.77	4.20	3.24†	18.75	22.50
American S. J. and Portuguese	5.80	15.12	16.92	8.06	1.12	16.40	23.10
American S. J. and Span.-Mex.	8.00	7.87	12.67	7.46	4.56	9.55	24.00

* The American S. J. exceed all groups in alpha by these differences.
† In beta V, the Italian S. J. exceed the Americans.

TABLE XXXIII. DIFFERENCES IN THE PERCENTAGE OF ZERO SCORES IN EACH SEPARATE TEST

ALPHA TESTS

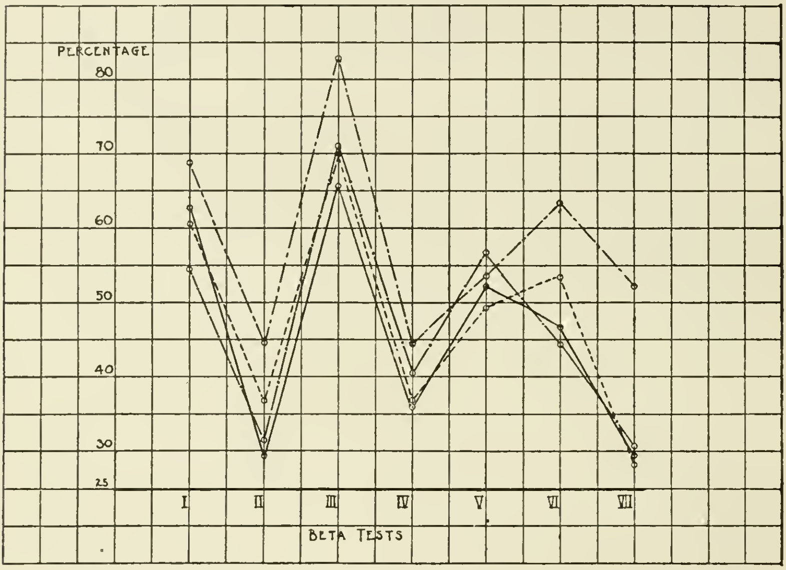
Difference in %—	I	II	III	IV	V	VI	VII	VIII
American S. J. and Italian S. J.	19.60	10.40	16.10	29.00	23.00	24.10	23.70	18.00
American S. J. and Portuguese	25.00	5.60	33.00	48.00	24.40	16.30	25.60	15.80
American S. J. and Span.-Mex.	20.20	12.70	23.00	39.70	30.60	12.30	32.50	14.50

BETA TESTS

Difference in %—	I	II	III	IV	V	VI	VII
American S. J. and Italian S. J.	8.10	12.20	.50	4.70	1.90	.50	15.60
American S. J. and Portuguese	4.70	3.50	2.70	5.40	2.00	2.70	10.60
American S. J. and Span.-Mex.	1.20	1.90	1.90	3.80	3.10	.00	11.60

ii. The Beta Tests. Tables XXX to XXXIII and Graph V show the same facts for the separate tests in beta as for the alpha. The means for the separate tests, with the S. D. and P. E. of the means, and also the S. D. and P. E. of the distributions are given. It is apparent at once, as it was for the averages and dispersions of the total beta, that the groups are much nearer together in their performance in these tests than in the alpha.

GRAPH V. PROFILES SHOWING THE PERCENTAGE WHICH THE MEAN OF EACH TEST IS OF THE MAXIMUM POSSIBLE SCORE IN EACH TEST FOR BETA



(Legend as in Graph I)

The percentage of zero scores is negligible except in the case of test VII for all Latins, and also test II for the Italians. In tests III, IV and VI the Americans had no zero scores whatsoever. The other tests yielded low percentages throughout. In the case of test II for S. J. Italians, no special explanation is available. It is unlikely that the Italian group is deficient in the abilities needed in cube analysis when compared to other Latins. Anyway, in terms of the mean for test II they exceed the Portuguese and are only slightly lower than the Spanish-Mexicans, hence in the percentage of the maximum score in test II reached by the mean, the matter of the percentage of zero scores is wiped out. Were the percentage of zeros not so high, of course, the mean itself would be greater.

In test VII the matter appears really one of the difficulty of the test, for all the Latins have a considerable percentage of zero scores, with the Italians exceeding the other two groups. Geometrical construction (test VII) may involve for the 12-year-old South European child difficulties beyond his innate capacities.

Graph V pictures the relative standing in the separate tests in terms of the ratio of the mean in each test for each group to the maximum score possible for that test. While the Americans do not outstrip the Latins so extensively as in alpha, they maintain their superiority in each test, with one exception. For the Italians in test V (number checking) the mean is slightly greater than it is for the Americans. In tests II, III, VI and VII the Americans exceed the Latins more than in I and IV. In V the former only slightly surpass the Portuguese and Spanish-Mexicans. It is interesting that even in test II (X-O series) which is probably the easiest test of the entire set, which permits of unwarranted attainment of a score (through chance making of cross and circles without comprehending *why*) and is facilitated by rapid motor activity, the non-Latins increase their lead over their fellows. In tests IV and V, which are decidedly perceptual tests, the Latins earn more comparable scores with the non-Latins. Test VI (picture completion) is a type used in numerous performance scales and appears to have a high reliability and to differentiate among mental abilities very well. Comment on test VII has already been noted. On the whole, with beta the general rise and fall of the curves for the various groups parallel each other. Once more one is forced to conclude that the differences are those of relative standing, or degree, not in any instance differences of "kind."

Tables XXXI to XXXIII present the differences in the percentages of the maximum scores reached by the means, and the actual differences in the means with the P. E.'s, and also the differences in the percentages of zero scores. The differences in the means are true pictures of the facts as indicated by the relative size of the P. E.'s. In other words, another sampling might show that the second group mean would exceed the first. This is particularly true of the differences in the means of the Americans and the Italians and the former and the Portuguese.

F. Conclusions to Part 2.

A survey of the various methods of measuring the differences in the mental ability of the foreign population of a school system and comparing the same to the school population that is "native" American, in the sense that its ancestry were the early settlers in this country, shows some tremendous differences. In grade location the Latin stocks are nearly two grades on the average below those of the non-Latins; teachers' ratings of the general intelligence of these groups show that the former lie on the average one-seventh of the total range of the scale below the latter. Nearly the same results are present when the actual measures of school success are given. It must be rigorously held in mind that the children compared are *all of the same chronological age.*

So too with the results of mental tests applied to the children. In the alpha the differences are very marked. In beta, while they are not nearly so great, they are still significant. The query arises why the beta differences are not so noteworthy as the differences in alpha. Is it not true that the language handicap is after all the pertinent explanation here? And if it is not so, why does not the beta difference show itself to be greater than it is? In reply one may raise other questions: Do alpha and beta test similar mental functions? Are they really comparable measures of innate mental ability? Or are there features in the tests themselves that may, at least in part, explain the problem raised in the question above about the wide divergence in alpha and the much less amount in beta?

Before going into an attempted answer to these questions, it will be necessary to see what the correlations of the various measures among themselves may show as to possible cues in the interpretation.

3. CORRELATIONS

The bare results of correlations will be presented here, the significant comment on the findings being reserved for the final section of the chapter. It must, however, be noted that two assumptions are held as valid: first, that the degree of correlation between the alpha,—the verbal test, and beta,—the performance test, will reveal the extent to which they are testing, if not identical, at least very comparable mental processes; second, that teachers' estimates of general intelligence and of school work, coupled with the grade location and possibly parents' economic status serve as legitimate checks upon the mental measurements, for if the latter are valuable for diagnosis and prediction, they must show some relation to already known criteria of success.

A. Correlations of Alpha Against Beta.

Table XXXIV presents the correlations[25] of the various criteria with the tests. The correlation between alpha and beta is high. The S. J. Americans and the Misc. Americans have a correlation coefficient of nearly .62. The corresponding correlations for the Latins range between .58 for the Misc. Italians, which is a rather small sample with a somewhat larger P. E. than the other groups, to .79 for the Portuguese. The S. J. Italians give an r of .67 while the Spanish-Mexican group is slightly lower, .73. The P.E.'s of all these groups is significantly small, indicating high reliability of the samples employed. All Latins grouped together give a correlation of alpha against beta of .736 P. E. .016.

TABLE XXXIV. CORRELATIONS BETWEEN VARIOUS TESTS AND OTHER CRITERIA COLLECTED ON RACE GROUPS (Pearson r formula)
(All correlations are positive)

Race Group	r with Beta	r with T.E.Int.†	r with T.E.Schw.	r with Grades	r with Taussig	r with Barr.
Amer. S.J.						
A	.615*.024	.698 .019	.607 .024	.762 .016	.215 .036	.388 .032
B		.498 .029	.413 .032	.543 .027	.221 .034	.238 .036
Comb. A and B		.670 .021	.574 .025	.742 .017	.316 .035	.356 .034
Ital. S.J.						
A	.671 .022	.674 .027	.511 .036	.779 .018	.405 .041	.309 .044
B		.533 .035	.428 .039	.751 .022	.336 .043	.175 .047
Comb. A and B		.687 .025	.558 .034	.815 .016	.405 .041	.311 .044
Port.						
A	.788 .029	.487 .058	.398 .064	.812 .026	.354 .067	.224 .073
B		.670 .040	.455 .061	.705 .038	.175 .075	.192 .075
Comb. A and B		.706 .038	.461 .061	.799 .028	.311 .070	.286 .072
Span.-Mex.						
A	.726 .044	.563 .065	.384 .081	.773 .038	.449 .076	.212 .090
B		.596 .059	.404 .077	.813 .033	.436 .075	.227 .088
Comb. A and B		.587 .061	.436 .076	.842 .027	.414 .079	.241 .088
Ital. Misc.						
A	.582 .065	.652 .050	.554 .062	.673 .049	.223 .086	.269 .083
B		.481 .070	.354 .080	.649 .051	.422 .076	.308 .082
Comb. A and B		.688 .048	.461 .072	.750 .040	.497 .070	.319 .082
Amer. Misc.						
A	.618 .045	.644 .042	.542 .051	.752 .031	.225 .068	.168 .069
B		.590 .047	.525 .052	.605 .045	.411 .076	.354 .064
Comb. A and B		.684 .039	.584 .049	.772 .030	.259 .067	.284 .067

* The second figure in each case is the P. E.
† T.E. means Teachers' Estimates.

There is reason to believe, then, that the alpha and beta, while not exactly comparable, are fairly so, and that they are tapping much the same mental processes. The lower correlation for the American groups is due to the fact that the beta, as has been noted, does not differentiate their abilities in the upper ranges and hence the range of scores is much more narrow than a test adequate to their abilities would be. In the army testing, alpha against beta gave an r of .811, P. E. of .009, with 653 cases of English-speaking men from nine camps (73, p. 392). This group was less selected for intelligence probably than the group of 12-year-old school children of older American stock.

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[25] All correlations were computed by the Pearson Product Moment Method, using the short method of Rugg. The correlations are always plus unless otherwise stated.

The outstanding fact, of course, is the high correlation of alpha and beta in the case of the Latin groups, indicating that much the same mental functions are involved throughout, and shows the verbal test *is* diagnostic of their ability.

B. *Correlations of Alpha, Beta, and Combined Alpha and Beta with Outside Criteria.*

i. Teachers' Estimates. Using the mean of two ratings[26] on the children for general intelligence and for quality of school work, the correlations of each against alpha, against beta and against the combined alpha and beta total scores were computed. (Cf: Table XXXIV.) The range of correlations of alpha with intelligence ratings is from .50 to .70. The Portuguese and Spanish lying near the former figure, while the other groups are close to the latter. These correlations may be considered particularly high, as such correlations run (73, Pt. II, Ch. 11).

The correlations of beta with estimates of intelligence show fluctuations in the groups that the alpha do not. With both American groups the correlation runs between .50 and .60, while with the Spanish-Mexicans and Portuguese they run between .60 and .70. There may be a qualitative set of factors accounting for this better showing of beta than alpha with the latter.[27] Nevertheless these correlations of the performance scale with the estimated intelligence are significantly high. On the whole they are as high for beta as for alpha.

The combined alpha and beta correlations with rating of intelligence come under the same range of coefficients as the separate batteries.

With school work there are several factors to be taken into account. While mastery of school subjects is basically dependent on general intelligence, the grading system in terms of mental age is so unsatisfactory that the children are not where their abilities would really place them. If the children were all properly placed according to their mental age, then the correlation of mental test with grade location would be practically perfect; at the same time, the correlation with teachers' estimates of school work would be zero, assuming the child was doing his maximum work. That is, the child of given mental age would be put in the proper class and could only be justly rated as "average." That, of course, would mean no correlation with mental tests in terms of variables. Of course, in a practical situation even with grading on a mental age scale, the school work of pupils would differ somewhat in quality, and hence estimates from teachers of such classes could be put on a scale of short range at least, which would produce some slight correlation. It is because the children are less adequately placed in the school system in terms of their mental ages that the correlations of the tests with quality of school work are as high as they are.

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[26] The r of the first rating on intelligence against the second equals .797; first rating on school work against second, r equals .807. This indicates in another way the reliability of the ratings.

[27] The beta throughout shows up better with the Portuguese and Spanish-Mexican groups than alpha. This appears rather due to their low intelligence than to alleged language difficulties.

This last fact, coupled with the disposition of the teachers to over-rate the foreign children generally, adds to the cause of the present correlations. Moreover, success in school work is not entirely a matter of intelligence. So-called non-intellectual traits enter into the pupils' success.

The American children are often penalized at the opposite end of the scale than the Latins. They are found in grades too easy for them, and there is a disposition for greater displacement up or down the scale than with the Latins. This may serve to increase the correlations of the American groups in alpha against quality of school work. While the tendency for the teachers is to rate the quality of school work of the retarded Latin's average with his class, the American who is advanced for his chronological age will be rated lower than average (though as a matter of fact his school work is probably average in his grade). Such a displacement would produce a higher correlation of the test against quality of school work for this group than for the Latins who would be closely grouped around the "average" point on the scale, hence lowering their correlations.

In the beta the correlations of all groups are much more uniform. The lowering of the correlations of the American group to the level of the Latins is likely due to the shorter range of the beta for them, which would offset, for instance, the spread of the ratings on the seven-fold scale of the teachers' ratings. With the Portuguese the beta correlation is higher than the corresponding alpha. The sample is small and the P. E.'s indicate that the difference is not great since other such samples might fluctuate between the two coefficients, for either alpha or beta against school work. The general range of correlations for school work is from nearly .40 to slightly over .50. These are not high but are large enough to indicate the relation between present schemes of rating quality of school work and the mental tests. It must not be forgotten, as we just pointed out, that such correlations are really reflections on the inadequacy of the system of co-ordinating native abilities to opportunity for school progress, plus the influence of non-intellectual traits on school success.

The combined scales correlated with the school work will naturally smooth out the discrepancies between the results in the two tests. (Note the run of correlations in the accompanying table for the combined scores.) It must be remembered that the mere addition of a number of new tests to a battery tends in itself to raise the correlation, although the diagnostic value of the same may not be particularly enhanced. However, the results of the present study would indicate that the combination of alpha and beta gives a better diagnosis as measured against outside criteria than either. The verbal test alpha, nevertheless, is the most significant half of the combined test.[28]

ii. Grade Location. In all likelihood there is no outside criterion so objective as the grade location of the children at the time of testing. While even grading is somewhat subjective, it is a measure of the child's individual capacity and is relatively free from personal bias. In the long run the ordinary child finds his grade-level. The exceptions to this are rather the children of superior rather than inferior ability (111) who are held back with those not equal to them in native capacity. But with the average child and those slightly below average their grade location is a fair measure of their successful adjustment to the school program. In fact, it is the problem of discovering the reasons for the present grade location of large numbers of the children of foreign parentage that this study was undertaken. Table XXXIV shows that with one exception the alpha test gives higher correlations with grade location than the beta, and this exception, that of the Spanish-Mexican groups,—beta vs. grade location,—the difference is negligible, being well within the limits of the P. E. of either correlation. So even here, beta does not correlate markedly higher with grade status than does alpha.

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[28] The combined alpha and beta is not an adequate group test for diagnostic purposes in schools. A test made up of items both verbal and non-verbal might be devised which would be better for practical purposes than either alone.

The r of alpha against grade location ranges from .67 to .81. It is instructive that the correlations are somewhat higher for the Latins than for the Americans. The range of correlations of beta against grade location is from .54 to .81. Here, as with correlation of beta and teachers' estimates, the S. J. American group, especially, shows up poorly. It is increasingly evident that beta is less adequate for diagnosis for the non-Latin group than alpha. The difference in diagnostic value between the verbal test and the performance for the Latins, while present, is not so marked. The beta in the case of Spanish-Mexicans shows some superiority over alpha but not a significant one.

Combined alpha and beta against grade location gives higher correlations than either alone with the Latins, while for the Americans the inclusion of the homogeneous beta group lowers the correlation when it is compared to that of the alpha alone against grade. This is more true with the S. J. group than the Misc. Americans.

Pooling all the Latin groups together for a correlation of alpha against grade location, r equals .80, P. E. .012. For beta r equals .708, P. E. .014. The superiority of alpha over beta in correlation with the outside criterion, grade location, is noteworthy.

Table XXXV presents an array of correlation coefficients of the separate tests in alpha and in beta against the grade location. It was hoped that this might show which tests were operating to produce the correlation of the total batteries against grade position. Only the four principal samples were used.

The alpha section against grade location discloses the fact that tests II, III, IV, VII and VIII yield high results. The exact reliability of these individual tests is not known, yet assuming it to be high, as one may,[29] it is interesting that in the tests which approach the perceptual, like the first, and the arithmetic reasoning and common-sense which are not greatly dependent on language, the Italian and Portuguese do somewhat better as measured by these correlations. One might say, of the total eight tests, tests I,

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[29] From the fact that the reliability of the entire test is high and from the fact that tests of the same general types have always yielded high reliability coefficients.

II and III would serve as indicative of their ability, perhaps, if it is measured by such a relationship, better than the other four or five tests. Test VIII (Information) however, while pretty much dependent on reading and conversation, yields a high correlation for the Latin groups. The analysis of the percentage of zero scores in tests IV, V and VI , on the other hand, offers a cue that the reason for the low correlation in these tests is the high proportion of zero scores, which shortens the range and makes the group more homogeneous and the test less differentiating. A better test, of like nature, more commensurate with the native ability of such groups, would give a more adequate picture of the differences.

TABLE XXXV. CORRELATIONS OF INDIVIDUAL ALPHA AND BETA TESTS AGAINST GRADE LOCATION (4 Principal Samples)

	INDIVIDUAL TESTS							
Alpha	I	II	III	IV	V	VI	VII	VIII
Amer. S.J...	.534*.027	.626 .023	.668 .021	.607 .024	.508 .028	.553 .027	.564 .026	.661 .020
Ital. S.J.......	.652 .028	.630 .029	.681 .026	.463 .039	.553 .034	.535 .035	.605 .031	.656 .027
Port.	.657 .043	.658 .043	.691 .039	.483 .059	.539 .054	.684 .042	.636 .046	.718 .037
Sp.-Mex.	.708 .047	.673 .052	.589 .061	.511 .069	.479 .072	.681 .051	.625 .057	.716 .047
Beta								
Amer. S. J...	.200 .027	.173 .037	.320 .034	.345 .033	.470 .030	.290 .035	.281 .035	
Ital. S. J. ..	.503 .036	.302 .044	.534 .035	.585 .032	.588 .032	.514 .036	.457 .038	
Port.	.362 .068	.248 .073	.580 .052	.657 .044	.636 .046	.298 .071	.299 .071	
Sp.-Mex.	.461 .073	.466 .072	.551 .064	.673 .051	.648 .052	.606 .058	.502 .069	

*The second figure in each case is the P. E.

It is striking in view of the objections sometimes raised against verbal tests for the immigrants and lower social levels of population that tests VII and VIII give such high correlations. Therefore, altogether, were tests IV and V more fitted to the capacities of the 12-year-olds generally, Latin and non-Latin, the usual language factor as a hindrance to success in them could not legitimately be put forward. The experience with verbal tests arranged especially for school children proves this fact.[30]

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[30] Pintner and Patterson (81) and others interested in performance scales maintain that verbal tests are unjust to many children and adults. The writer of the present monograph does not believe the verbal tests so unjust, except to certain sub-normals and to non-English speaking immigrants who have recently arrived in this country. Up to the present the performance tests have failed to provide such items as tap the "higher thought processes." On the other hand, studies of Terman and his students on the importance of vocabulary tests in diagnosing general intelligence and the high correlation of completion tests with outside measures, indicate lack of capacity, not handicap of language, as the factor in the difficulty. For instance, those who strenuously object to "language" tests for immigrants often forget the important fact that the majority of these immigrants have no grasp on their native tongue. They would be quite as much at a loss if the verbal tests were couched in their language.

More important than verbal or non-verbal tests, is the proper inclusion of such content in any tests as probe the true ability of the persons tested. More injustice is done the non-English speaking immigrants when the tasks before them are put into forms and experiences of which they know not due to difference in cultural background.

Recently Pintner and Keller (82) have compared the results of the Pintner Non-Language test with the Binet and discovered that for kindergarten, first and second grade children at least, the Binet tests do not give as favorable an I. Q. or mental age as the non-verbal test. The reliability of the non-verbal test is not given, nor its

The correlations of individual beta tests against grade location disclose lower coefficients throughout than the alpha. Since the correlations of beta total score against grade location is lower than the alpha, except in one case—Spanish-Mexican— and there the difference was not great, it is to be expected that the correlations of the individual tests with outside criteria would be lower. With the Americans, other things like reliability and length of range being equal,[31] tests I and II are decidedly too easy for the Americans, test VII only fairly so. With the Italian and Spanish-Mexican groups these tests are much better single measures. Tests IV and V seem from these correlations, at least, to be the most reliable individual measures for the American group.

Reference has already been made to the fact that the beta test appears on all sides to be slightly more favorable for measuring the Spanish-Mexicans. The evidence here corroborates this belief again. In all cases the correlations are rather better than with either of the other groups, Latins or the Americans.

It must not be forgotten that the evidence from these few samples of separate correlations do not always reveal the adequacy of the single tests. Extended inter-correlations and correlations of individual tests with other outside criteria, correction for length of range in each test, etc., would have to be made. The interest in this study lies more in the fact that these composite batteries of mental tests do prove adequate measures of native ability when compared to the best outside standards of judgment that can be found. Their results, however, are by no means absolute. The results can not rise above their source.

iii. Social-Economic Standing of the Parents. The Taussig scale which was used to classify the parents' occupations has already been mentioned. One set of correlations (cf: Table XXXIV) is based on this scale. A second scale of grading occu-

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correlation with the school standing of the children, its correlation for both foreign and native children with Binet is low, and further the number of cases was small. Moreover, in the material presented in the present thesis, the age group was advanced over Pintner's and the children's families were likely of longer standing in this country. It is difficult to measure the extent of the home influence on the language.

It must not be forgotten that in school procedure what is desired is predictability of performance with school materials. It is yet to be shown that the group performance tests so frequently invented serve as well as Binet or other partially verbal tests for the diagnostic purposes of school practice. The writer does not wish to be dogmatic but he does hold that his results have got at the problem in a fairly significant way. Cf: (18).

[31] Carl C. Brown gives the length of range for the various beta tests as determined in the army: Test I has a range of 1.2 S.D.; II has 2.6 S.D.; III has "nearly unlimited range"; IV has 2 S.D.; V, 2 S.D.; VI, "nearly unlimited"; VII, 1.5 S.D. These figures were taken from a sample of 672 cases of enlisted men. The fact that the American 12-year-olds did so well in several of the beta tests indicates that its length of range and its difficulty should be increased.

pations was used, that of Barr, who devised a scale from the composite judgments of twenty persons as to the amount of general intelligence necessary for success in a list of 121 occupations.[32] This composite judgment by rank-order was worked over into a frequency curve and a P. E. value was assigned to each occupation on a basal range of 4.6 P. E. Then those occupations lying contiguous on this scale of P. E.'s were thrown together into fourteen classes for the entire scale. While there are some obvious difficulties in the method of devising, the scale is better than any individual judgment of vocations.

The table reveals considerable fluctuation within the groups. On the whole alpha correlates more highly with the occupation scales than beta, but the tendency is not constant throughout. Note the Misc. Italians, Misc. Americans, especially. Also it is not evident from these correlations which of the two classifications is the better for these groups. The beta with Barr scale gives on the whole low correlations with such large P. E.'s as to be of little value, and the writer desists from any attempted explanation of these facts beyond the vague, general one, that the immigrant groups have not yet found their levels of occupation commensurate with their native abilities, and that the Americans, while giving somewhat higher correlations, may also be said to be classified on other strata than those of intelligence alone, and finally the inadequacy of the scale itself. There are so many factors entering into one's economic situation,—ambitions, interests, attitudes toward the unscrupulous accumulation of wealth, inheritance of unearned increments, and so on,—these obscure the place that general mental capacity plays in selection and success in vocations.[33]

On the whole, in spite of limitations of sampling and inadequacy of the scales, mental and occupational, some correlation is discovered. If alpha be assumed a better qualified test of innate ability than beta, its correlations with the Taussig scale in the case of the Portuguese and Spanish-Mexicans and with the Barr in the case of the Americans might be used as a basis for holding that these groups are roughly segregated into economic levels according to their mental abilities, that is if we may assume further that the intelligence level of the parents is highly or perfectly correlated with that of the children as shown in the alpha.[34]

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[32] While Barr doubtless had a fertile idea in his thesis, his group of judges (college professors, graduate students, and a few others) was too homogeneous in interests and experience. His sample of opinions, in other words, was too narrow. If he had included business men, industrial managers, industrial engineers, foremen, and even skilled workmen themselves among his judges, the scale would have been more valuable. Of course there remains the further difficulty:: There are no standardized categories for the various occupations. For instance, take nursing; while nurses are rated high by Barr's judges, evidently thinking of graduate, well-trained persons, in actual practice many women rate the title "nurse" who never had a day of hospital training. The writer came across such cases. So too with "carpenter,"—this trade runs from the high-grade skill demanded for indoor finishing and cabinet-making to rough "wood-butchers." The former likely possess, on the average, a good deal more mental ability than the latter. There is also the question of specific skills and ability.

[33] There is a real need for an extended survey of: (1) the mental ability in the various occupational levels of our population; (2) the existence of special aptitudes for different occupations; (3) the place economic and educational opportunity have in the selection and success; and (4) the place non-intellectual traits may have in selection and success.

In conclusion of this section, we may say that the correlations of alpha versus beta show that, in the main, these two tests are comparable. The high correlation of the Latin alpha with the outside criteria, especially grade location, is the second most significant feature. For our purpose, the indication that the alpha test does not do injustice to the Latin groups, as measured by these correlations, is important. The problem of the alleged language handicap must, therefore, be interpreted in the light not only of the measures of central tendency and dispersion in these tests, but also in view of the correlational material.

4. Interpretations and Discussion of Data

First of all, are the alpha and beta comparable tests? This question has been partially answered above. While the correlation of alpha and beta together gives a high coefficient, it is not high enough for these groups to warrant saying that it approaches perfect correspondence. It is not so high, at least for Americans, as the correlations between alpha and beta uncovered in the army experience. Nevertheless, the uniformly high correlations of the verbal alpha against the non-verbal, beta, indicates that the alleged language handicap is not present to the extent imagined by the teachers and school officials.

Two difficulties with the tests used must be noted to get the proper perspective. Alpha, while proving very good for differentiation of the American groups as a whole, was too difficult for those Latin 12-year-olds who were mentally retarded. While much has been written about the verbal test as involving mere linguistic fluency, I take it sufficient proof to the contrary has been offered in experimental literature to overthrow these opinions.[35]

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[34] In the case of the Latin groups classified by Taussig, there exists only four classes which lowers the correlations because it shortens the range, etc. A scale of four units is really too short to be used by the Pearson Product Moment method. From this standpoint, other things being equal, the Barr is preferable.

[35] Cf: (129, 102) and other studies. There has been considerable discussion of this problem by certain philologists like Max Müller, who maintained that language and thinking (in the broad sense) are inseparable. Cf: (52) I:263 for quotation from Müller.

At least the severe adherent of the other view must bear the burden of proof to the contrary. It is nearer the truth to say that the highest mental adjustments take place in terms of secondary processes ("derived implicit behavior" one behaviorist has called it), processes largely in terms of symbolic imagery, language and other "short cuts" and "cues" to facilitate "advance adaptation." It is true as James[36] succinctly illustrates that mere flow of words is no criterion to thought. Yet as Mead, Dewey, and latterly Watson[37] have pointed out, thinking does go on in language, that is, symbolic terms, and that these "implicit" adjustments are exactly what make for success or failure in the complicated problems of life must be admitted, since these permit foresight, preadaptation, preliminary solution. Certainly we must distinguish between sheer superficial fluency and the actual use of language symbols in thinking. Tests which do not take these distinctions into account are of course inadequate. Good vocabulary tests (which would take into account qualitative differences), well-constructed completion tests, and analogies and proverbs tests do *not* constitute tests of mere verbal fluency. A composition scale, accentuating verbal ornateness, on the contrary, might be such. (cf: 91).

As was pointed out above, those tests in alpha which are especially difficult from the language side yielded lower averages because of the percentage of zero scores, and zero score, as has been noted, is not synonymous with *no ability at all*, but means that the instrument of measurement did not register. Moreover, the percentage of zero scores was high for all the 12-year-olds in tests IV and V, only relatively greater for the Latins than for the Americans. The accusation of language against test VI in alpha cannot be made, yet the percentage of zero scores in certain of the Latin groups is high there. Further, test VIII (Information) which is at least indirectly dependent on communication and language yields high correlations with grade locations and also shows a higher mean score than would be expected if the language factor operated as might be imagined. On the other hand, Oral Directions, Arithmetic Reasoning, Number Completion, and Commonsense Judgment are not greatly dependent on language and show that the Latins do not compare with the Americans at all favorably.

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[36] Cf: (52) I: 263 for an illustrative quotation from a writer who covers ignorance of scientific fact with high-sounding words.

[37] Cf: (130, 29, 72, 19). G. H. Mead and Dewey both point out that thinking goes on in symbolic terms. Language is a form of gesture, but highly complex and integrated. It is preparatory to activity of a grosser ("explicit") kind. "Meanings," "interpretations," "adaptations" are carried in symbolic terms (sensory and imaginal at root) but functionally organized around methods of adjusting to the world about us.

To test the influence that the zero scores might have on the correlations of alpha against grade location (as the best single criterion outside the test), all cases having zero scores in any of these four tests were thrown out and the results correlated with grade. The S. J. Italians who were used as a sample for the Latins, gave r of .64 and the S. J. Americans, r of .57. The alpha still remains a better measure of educability than the beta.

It is difficult to devise a test in performance which is completely analagous with a verbal test, since the mental processes making for success in the latter are difficult to put over into tasks required in a performance scale. Stockton (102) has tried to show experimentally that there are two levels of mental performance. On the basis of his results it is clear why the alpha may have proved too difficult for the Latins. It was not language, but ability, that brought out the lower scores.

So on the other hand, with beta and the Americans. The motor-perceptual features of this test might operate to handicap the brighter children of this group, or, as was likely the case, the test battery proved much too easy to differentiate them in certain of the items, as tests I, II and possibly VII. This inadequacy of beta for the Americans made for more homogeneity in the group than the facts really warranted. This lowered the C. T. and dispersion possible in another, but better, test, and also caused the lowering of the correlation of beta against alpha.

With the beta differentiating the Latin groups fairly well, the significant thing then is that alpha, the verbal test, proves so diagnostic of their abilities in spite of its nature. We have seen that in teachers' estimates of intelligence and school work, in grade location, the Latins lie below the Americans, and so in the mental tests themselves. While the overlapping of the Latins and Americans even in beta is slight, the fact that with the Latins the correlations of the alpha against the outside criteria is uniformly high, goes to prove that the wider overlapping of the alpha is a much truer picture of the facts. Had the beta test been just to the Americans, the overlapping there would have been similar to that in the alpha.

The up-shot of the whole matter is that the alleged language handicap of the Latins simply *does not exist to the extent imagined.* All the measures used in this thesis prove the contrary, and only with the very youngest pupils and those newly immigrated could it play an extreme but rather temporary role. The writer stands firmly on the ground that the cause of school difficulties must be found in the more innate intellectual differences. If the differences are language ones, then even with the obvious handicap of the beta for the Americans, the Latins ought to far outreach them in beta.

Other studies have confirmed the same findings. Dickson (31) found that the Median I. Q. of 23 Portuguese first grade pupils was 84, that for 37 Spanish-Americans, 78, and for Italians, 84. In comparable groups, the I. Q. of 63 pupils of Northern and Western European descent, was 105.5. The survey of X County, in California (133) demonstrated that feeble-minded children were several times as numerous among the Latin groups similar to these (in part the same) studied here, as among the "native" American stock. The number of delinquents and offenders in prison for these groups far outnumbers their relative percentages in the population (114, 134). Roll (114) made a study, under Terman's direction, of 119 Portuguese children in Santa Clara and found that these children had a median I. Q. of about 86.

Murdock (76) in a study of certain grades in the public schools of New York City, showed that the Italians did more poorly than any other of the three groups studied. These groups included "native" Americans (not of the best, but of lower middle class families), Hebrew and Italians of first and second generations in this country, and Negroes. The overlapping of the 12-year-olds studied revealed that 13.5 per cent of the Italians exceeded the median for the Hebrews, 50 per cent of the Amricans, and 33.33 per cent of the Negroes. The Italian group was selected so as to eliminate the poorer pupils or those thought to be handicapped with language difficulties, while in the other groups the pupils were taken as they came. The test was not a performance test, but since the pupils suffering from language handicap were not selected, the question of the nature of the test in that regard may be ignored. The important thing is that the Hebrews, who had been no longer in this country than the Italians, did as well as the "native" Americans, while the Italians did not equal the Negroes. Murdock's results are particularly confirmatory of those of the present thesis.

Brown (18) has recently added another study of the intelligence of various nationality groups. He found the median I. Q.

for 51 Italians around 77. The Italian group with which he worked, however, was of very low mental calibre throughout. Pintner and Keller (82) report the median I. Q. of the Italians whom they studied as 84. In their group the Italian seemed to be of higher level. Brown's group contained 76 per cent who were below the normal for their age, and this is, as he pointed out, the principal cause of the school retardation.

If the matter of school success with these Latin children is environmental, then the longer they remain in school the better their condition mentally ought to become, for the influences of home would be overcome.

Thomson (118) recently made a study of the same pupils who had been tested by Dickson, some three to five years earlier, to discover if the school conditions had improved the I. Q. ratings of the pupils. She worked with a group that consisted of children of Latin origin on the one hand, and of North European descent on the other. After correcting the first I. Q.'s for the discrepancies of chronological age that the re-testing uncovered, she found that the average change in the I. Q. downward was slightly greater for the Latins than for the Americans. On the whole the I. Q. remained very constant, however. She says (p. 88):

> It seems that as a whole the tests are as accurate a judgment of the mental ability of the low foreign element as of the American children. . . . Furthermore the fact that the central tendency of change is almost as low on the minus side for the South Europeans as for the other groups, tends to show that they are really of low intelligence; had language difficulty caused the first low median, the central tendency of change would now be plus. It seems evident that although the tests do involve the use and understanding of language, low scores result not from failure to understand, but from failure to comprehend.

One further check on the reliability of a language test to diagnose the mental capacity of the foreign children was made. All the Italians who were born in Italy were thrown together into correlation arrays of alpha against grade location, and beta against grade location. In these children, surely, if anywhere, the language handicap ought to come out. The correlation of beta against grade situation was .72; for alpha against the same criterion, it was .76. While the P. E.'s, .05 and .04 respectively, mean that another sample might show results practically identical, it still remains pertinent that the verbal test *is as good a measure of the mental ability of these children* as is the non-verbal, if not better, and even with the children who have been in this country not over five or six years. This ought to dispel any further doubts as to the answer to the problem which we, at the outset, put before us.

In general summary of this chapter we may lay down the following facts:

1. The Latin pupils in our sample are decidedly inferior to the American children in general intelligence when measured by the teachers' estimates, and this in spite of the tendency of the instructors to over-rate the Latins.

2. The Latins are likewise inferior to the Americans in their school work, though here as in (1) they are over-rated. In both (1) and (2) the mean difference between the Americans and the Latins is between one-seventh and one-eighth of the total range of the scale upon which they were rated.

3. In grade location the Latins lie on the average nearly two grades below the modal grade for the Americans. If it be thought that the average I. Q. of the American group in its modal grade be 100, then the average I. Q. for the Latins would be near 83, assuming that all the children were graded according to their abilities.

4. The economic status of the groups differs widely, but the mean intelligence score of the children whose parents were classified indicates that there is a rough relation between occupational status of the parents and the general intelligence of their offspring in the public schools. The mental tests show some correlations with the occupational ratings. If not large, these are at least indicative of a certain disposition of the occupational level to reflect the general ability of the families.

5. The psychological results show in the case of alpha: (a) Considerable difference in the C. T. and in the variability. Not only do the Americans outrank the Latins on the average, but they are also much more variable. (b) The measurement of overlapping reveals that about 7.0 per cent of the Italians exceed the median performance of the Americans in alpha. For the other Latins the per cent exceeding the American median is still less. Only 1.0 per cent or less exceed the upper 25 per cent of ability of the Americans.

6. Like results for beta show: (a) That the Americans significantly outstrip the Latins even in the performance, non-verbal test and this in spite of the fact that the beta does not differentiate the abilities of the Americans. This latter makes the variability of the Americans slightly less than in the Latins, but not greatly

different. (b) The overlapping, while greater than with the alpha, shows that but from 11.5 to 16.1 per cent of the Latins exceed the mean of the Americans, and but from 5.5 to 7.0 per cent of the former exceed the upper 25 per cent of the latter. Even if one accepts the beta results as a true picture of the comparative mental capacities, the results would still indicate extremely large differences in native ability as measured by the tests.

7. The correlational results indicate: (a) That the alpha and beta are fairly comparable tests, but that the alpha as measured by correlations with the best outside measures of school success and of general intelligence is somewhat better for diagnosis of mental ability even with the Latins than is the beta. Only in the case of the Spanish-Mexicans where the general level of ability is low and does not reach into those abilities demanded by the alpha throughout, does the beta show up more favorably than the latter. For pupils as inferior as these, either of two scales ought to be applied: a performance similar to beta, or a verbal test, more commensurate with their mental ages. There is evidence from the correlations of the individual alpha tests against grade location, that the language handicap does not operate beyond what it would in terms of mentality and that a good verbal test fitted to their intelligence would serve for segregation and prediction better than a non-verbal. For that matter, this same comment applies to all the Latin groups.

8. In conclusion, the writer believes that he has shown: (a) That the alleged language handicap does not in fact exist in the case of the children of South European descent, to the great extent imagined. It serves as a handicap chiefly for those newly arrived in this country, but of these, those who have the capacity do acquire the tools rapidly and those who have not the capacity remain on a lower level of ability.[33] (b) That the true difficulty is one of mental capacity, or general intelligence, which makes the Latins unable to compete with the children of North European

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[33] Borncamp (13) in his study of Orientals in California showed that as soon as these children acquire the rudiments of English they forge ahead in their school work. The Orientals seem to compare very well with the older American population in ability. Cf: Yeung's study of Chinese children in San Francisco (140).

Jordan (54) dealt with almost exclusive North European stocks in his thesis. The tests he used were not general intelligence tests, but single psychological tests of differing diagnostic value. He showed no correlations with outside criteria and no degree of overlapping. He emphasizes strongly the influence of the language handicap. Brown (18) on the other hand remarks: "It was found that after a child had attended an American school for one or two years, he tested as high (on the Binet) by employing the English language as by using his native tongue." In the present study the 12-year-olds had been at least five years in attendance in the public schools with the exception of a few cases, in which latter the language handicap did not operate anyway.

ancestry in the mastery of the traditional American public school curriculum. (c) If the facts of mental heredity be taken as valid, these findings throw great light on the problems of racial mental differences. The writer does not assume that these samples studied here are typical of *all* South Italians, Portuguese, and Spanish-Mexicans, but for the classes of people studied he does maintain that the results are significant. Discussion of the bearing of these findings on questions of school policy, of immigration, race mixture and the theory of racial differences will be handled in the following chapter.

CHAPTER IV. THE APPLICATIONS OF THE DATA TO THE PROBLEMS

1. Modification of School Policy and Curriculum

With the data concerning the intelligence of the children of South European descent before us, what changes in the educational program must be made to cope more adequately with these facts? This section will deal briefly with a review of the educational changes which are essential.

One need not raise the question of innate endowment versus environment as the chief cause of mental differences when dealing with practical school problems of the foreign children. First of all, the problem for the school administrator is not fundamentally one of race but of the educability of all the pupils with whom he has to deal. Of course, if the bulk of the mentally retarded in any given school system, as San Jose, turn out to be of Latin stock, then in one sense the question does involve racial differences. The comparable point, however, for the country at large is this: If the stream of immigration from Southern and Eastern Europe continues to inundate us, the schools must take into account the mental abilities of the children who come from these racial groups. Without attempting to say whether a few generations of residence in this country will raise the average intelligence of the peasant peoples who come to the United States, the truth remains that the mass of the Southern European immigration of South Italian, Portuguese and Spanish extraction, and the Mexican immigration from our neighboring republic bring us retarded material which the public schools have to handle. So long as entrance into this country is unrestricted, the schools will have an ever-recurring horde of such pupils to deal with, including the first and possibly second generations after arrival here. The present situation is already causing a revamping of the curriculum and the general educational policy in many school systems.

On the other hand, if the differences in mental ability revealed in such samples as studied here applies to the bulk of the source of our immigration from South Europe and the inheritance of mental endowment, as revealed in the tests, be taken for granted, or even as a prominent factor, then the educational policy, even with the restriction of immigration, would have to continue in a modified form to care for the on-coming generations from these inferior stocks. Hence, whatever the theoretical and sociological phases be, for the school man *now,* they are of the same consequence. What he wants to know is *how* and *what* to do today.

The alterations will be treated under the headings: (A) new school policy; (B) administrative and supervisional changes; (C) curriculum changes accompanied by changes in teaching practice to go with them; (D) a public conscience and co-operation with the schools.

A. New Educational Policy.

The school systems investigated in this study are not unlike the majority of those of similar size throughout the country. There has been a tendency toward a business organization of the administration in terms of the educational *status quo.* The assumption has been that, so far as the elementary schools are concerned, barring a few minor changes, the old curriculum and the old organization have proved adequate. There has been little tendency to think of the educational program in terms of objectives in education, in terms of the mental abilities of the materials with which the teachers have to work, or to consider modifications in the course of study and the school procedure.

A new policy must grow, not out of arm chair discussion, but from a careful sociological-educational survey of the localities, the economic life of the inhabitants, what the children of the present will be doing in later life in industry and agriculture or business. And most important, must be investigated the general levels of intelligence in the school population that are to be instructed.[39]

B. Administrative and Supervisional Changes.

The notion that we must have a common school organization for all pupils must be given up. In order to care for the facts of individual differences, two general schemes are put forward:

i. Standardized intelligence tests should be applied throughout the elementary schools. While it is true that there are no very reliable group tests for individual diagnosis in the lower grades yet available, there are some scales that serve well enough for group classification.[40] Furthermore, Binet tests, teachers' estimates, knowledge of emotional features, analysis of home conditions and social status, will give good clues to individual treatment in the doubtful cases. Violent reclassification can not be brought to pass over night, and the logical places to commence in San Jose, for example, are in the schools so overwhelmingly Latin in population. In the case of the communities like Santa Clara, Milpitas, Half Moon and South San Francisco, where the school system is smaller, the administrative detail is not so difficult for the superintendent. Since the matter is one of relative educability, the approach is only suggested from the side of the schools predominantly foreign because it is there that the largest numbers of the backward are found.

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[39] Since the above was written a new superintendent has taken over the control of the San Jose schools, and so far as this community is concerned we may look for rather radical changes in school policy. The new executive is already carrying out some of the recommendations of this chapter.

ii. After the testing of the children with group and individual tests had been undertaken, reorganization within the teaching and supervisory units must be made. There are several schemes already in vogue in certain cities, any of which might prove, with local modification, applicable.[41] Any plan must provide at least for three classes of pupils, the mentally retarded, the normal, and the superior.[42] School people and the public at large must learn to give up the idea that uniform progress through the curriculum is possible for groups of pupils of varying abilities.

If in any given school system it were discovered that the influx of children born abroad constituted an immediate problem, special classes in English should be centrally located where these pupils could receive instruction in small groups in the mastery of English. Here performance tests might well be employed for tentative classification of the new comers according to native endowment. After given periods of instruction, other tests might be used, and as the pupils proved their capacity and gained the use of the English tools, they could be shifted into their proper places in the regular organization.

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[40] It is still an open question as to what constitutes "normal" intelligence. Doll (32) has recently attacked this problem with considerable data upon which to base his facts. Terman (113) differs from Doll. There is serious need of qualitative studies upon general intelligence. Purely quantitative approach can not succeed without its companion method. Cf: Boring (12) for a severe criticism of the present measurement of intelligence

[41] Cf: (71) for general treatment of present methods of dealing with the exceptional children in our schools. Cubberley (24) has a brief discussion, with references, to the Batavia, North Denver, Pueblo, Cambridge and other schemes of classification. Wright (138) has described what has been done in Newton, Mass., to accommodate those pupils with high school work, fitted to their abilities, but who are unable to master the traditional high school courses.

[42] Cf: (43) for a recent criticism of mental age classification in public schools. There is much work yet to be done before completely satisfactory group tests are at hand upon which to classify children. Some adverse critics, however, seem to forget the remarkable progress we have already made in this direction.

The kindergarten has been one of the great blessings in schools where the foreigners attend. It furnishes our most vital nexus between home and school. For the younger children just about to enter school it serves as a preparatory stage in overcoming the language factor from homes where this still plays a part. It is said that the Italian and Portuguese mothers "dump" their offspring on the kindergarten because it is a convenient place to leave them while they go to work. Be that as it may, it is important that the opportunity for building up bonds between the foreigners and the schools lies right here. Emphasis should be put on the importance of the kindergarten for formal education and also Americanization.

iii. Standardized pedagogical tests should be introduced. Through these and supervision a constant check should be kept on the educational product. The present methods of teaching, even the out-worn course of study, probably do not yield the educational results they might. With the introduction of re-grading and a new curriculum, pedagogical objective will become more definite and hence the need of checking these at critical intervals for the evaluation of the new organization.

iv. The methods of testing, both psychological and pedagogical, require for effective administration the employment of a research director for the schools. In a city the size of San Jose such a scheme is possible. With a present budget of $5,000 per annum, $3,000 for salary of research director and $2,000 for maintenance and materials, a tremendous saving could be effected in the whole educational process. With nearly 6,000 children in the elementary schools, this would mean a yearly expenditure of about 85 cents per child, or less than one-half a cent a day per child for the improvement of his instruction. Much more than this amount would be saved by the realignment of pupils on the basis of ability alone.[43]

C. The Curriculum.

The curriculum is the crux of the matter! Given a range of abilities measuring from those represented by the lowest 25 per cent of the Latins to those found in the upper 25 per cent of the non-Latins, what must be done to make the content of education more commensurate with the abilities of these pupils? The final answer can only grow out of empirical experience, but the following propositions may be laid down as essential:

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[43] With very little additional outlay, say $1200 a year for an assistant and a slight increase for clerical aid, one research director could cover the needs not only of the San Jose schools but the schools of the smaller towns like Santa Clara which cluster around it, and though separated by political boundaries, are economically and geographically extensions of San Jose.

i. The principles of curriculum making must take into account the need of preparation of the children for their proper economic life activities in accordance with their abilities.[44] Furthermore, the intellectual and moral heritage of the past must be given them, so far as they can assimilate it. This will include first a training for occupational efficiency, technique and habits of work; second, such habits and attitudes as make for social co-operation in political, economic and social organization, and also personal habits of efficient living, and third, training for appreciation of the content of the arts and sciences for satisfaction and happiness. The richest capitalization of capacities possible for each child, independent of economic background of family or of social prestige!

ii. The public and the school authorities must recognize the profound differences in the educability of the children who come to the schools. We are rapidly giving up the notion that all are of equal ability or of equal educability. The ideal that education wipes out all differences must be modified and the older notion of Plato, if you please, adopted, that education is for selection. The training in technique and information it provides, but only to those who are able to take it (cf: 80).

With this point in view, the school authorities may well go ahead to re-make the curriculum in terms of the abilities and needs of the pupils in its system. For those of average and better than average ability, the curriculum may include much of the older materials, reorganized albeit to fit the modern needs, for those who do not possess the capacities of the average school child, the curriculum must provide vocational training, and skills which will allow their best abilities to express themselves.

Society through its schools, however, must guard against the narrow meaning of "practical" education. Training which will afford the greatest possible economic independence and social competence for these levels of intelligence must be given. For example, training for skill in a highly specialized part-process of manufacturing only is bad practice. It may mean skilled workmen and higher profits in industry but it is not a *complete* education even for people mentally below par. There is some danger that the facts of individual differences may be abused. A sane social ethics must correct this contingency (30).

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[44] Such principles are laid down in Dewey, Bobbitt, Bonser, Snedden, and others. While these men have laid down the principles of curricula making, none of them has recognized the tremendously important matter of native endowment of the school population for which any given curriculum is made.

iii. The content of the curriculum for all three groups needs re-making. Recent studies and proposals are pertinent here.[45] The class-room teachers and also the principal and superintendent should have a hand in making the course of study. For the Latin groups especially the work that has been done in the Philippines, Hawaii and Porto Rico should be investigated. There, much has been accomplished to fit education to the requirements of the populations who are of like racial extraction to those considered here.[46]

It should be remembered, however, that the possession of even backward mentality does not preclude the possibility of considerable appreciation of the arts, literature, music and cultural products for these persons. It is a mistake to think that all the backward need is hand and eye education, and to leave the rest to those of better ability. True it is that the production of great pieces of culture as of science comes largely from special talent or superior ability, coupled with other factors,[47] yet the use and enjoyment of these products may be made to reach the great mass of mankind. There is much in science, literature, art and music that can be given these children of backward ability in their education.

Observation by the writer, which is confirmed by the library officials, shows that the Latin children who can, read great quantities of books of literary and mechanical turn. This should be encouraged. It is an interesting side-light on the alleged language factor. The bulk of Italian, Portuguese and Spanish-Mexican children learn to speak English as rapidly as they can. It is well-known to social workers that the children of immigrants ridicule their parents' inability to speak English, and that they themselves only use the foreign tongue when the situation actually demands it. These children read English books, play games with American boys and girls, enter rapidly into American life. The school but serves as a selective agent. Those who are mentally retarded remain in the lower grades until they may drop out of school, or are pushed on into grades beyond their abilities, to become serious discipline problems for the teacher.

With present tax problems what they are, the immediate future advances in educational administration will run naturally to internal reorganization. While building programs are always present, it is not wholly unfortunate that present financial conditions are forcing the attention of the boards of education and the school executives to look to reorganization of teaching, grading and curriculum for relief of the school problems rather than to mere expansion of floor space.

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[45] Cf: (11, 23, 77). Also the files of Bureau of Education reports.

[46] Cf: Bur. of Educ. reports on education in the Philippines, Hawaii, Porto Rico. Also Philippine Craftsman (Manila), a magazine devoted to the problems of education for the Filipinos. Cf: also (68, 70).

[47] Cf: *infra* Chap. V on cultural features.

Given the material equipment in buildings, a limited budget,—what can be done to improve the educational process? The most efficient reorganization of the school system from the inside will proceed on some such lines as are briefly outlined in this chapter.

The co-operation of the public in this school problem must not be passive. There is a tendency in our country to legislate reforms into existence in the pious hope that they will care for and operate themselves after they are devised. This attitude does not reach only the legislator. It is enlightening that the prominent mothers of one of the cities studied in this thesis who were greatly interested in Americanization programs for the foreigners, refused to send their own children to the school where the children of these foreigners attended, but secured permits from the superintendent of schools allowing their own children to transfer to the "better" schools. Such behavior speaks much and needs no comment.

iv. Teaching methods will be accordingly altered to fit the needs of the new classes. If much more vocational and manual arts work be introduced, if contacts with outside industry and business be established to care for the older pupils wishing to go over into occupations at once, the flexibility of the school system must be much greater than it is at present. The project method of instruction becomes strikingly pertinent to a scheme of re-grading and classification here outlined. Its possibilities are just now appearing.[48]

D. Public Conscience and Public Co-operation.

The above is a large assignment and can only be carried out slowly. It needs additional finances, no doubt, and these are dependent upon public opinion and support. It is not necessary at this point to go into the factors that enter here, but it must be noted that until a clear recognition of the place of the school in life adjustment is held by the thinking public, and further until a willing co-operation is forthcoming, the schools themselves must struggle on as best they may with the present means at hand.

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[48] Cf: Wells (139) on project curriculum. It ought to be noted that if the states continue the movement to enforce education up to sixteen years for *all* children, and part-time education up to eighteen, the content of the courses for those who are retarded or who have dropped out of school must be made to fit their interests and native abilities. For these children the curricula must not be patterned along traditional lines. Cf: (1) for outline on part-time education and other references. On immigrant education cf: Thompson (117). He has little or nothing to say concerning mental differences in the immigrant children as a cause of the educational problem.

Direct co-operation may be fostered by the neighborhood organizations, public philanthropic and religious bodies, but the center must be the school. With the coming of occupational specialization, rapid communication, and general complexity of life, the neighborhood as a social unit has almost disappeared in American cities. This is true even in cities the size of San Jose. People have been freed from the attachment and dependence of "face to face" contacts.[49] Yet the school serves the great purpose common to us all, and can be made the rehabilitator of those social values upon which our political structure rests. It may be made the center of a new neighborhood spirit.

The best hope for the schools which are organizing themselves along the modern lines internally is to co-operate with the outside agencies of sociological nature who are realizing the broader aspects of education and citizenship.[50] True, it means a new view of the profession of elementary teaching, it means conscientiousness on the part of the public of which we have no general evidence as yet, but it is in such hopes that the practice of the future is born. Before all else, a public conscience looking to an active co-operation in making the school the center of the social group life of the modern city or country, where people may come to enjoy, in accordance with their interests and intelligence, the cultural heritages of civilization and learn anew the human values of neighborhood co-operation and common purpose.

2. THE BEARING OF OUR FINDINGS ON PROBLEM OF RACIAL MENTAL DIFFERENCES AND IMMIGRATION

It is not the purpose in this section to deal at length with the problem of racial differences or mental heredity in reference to racial miscegenation in America. The writer has elsewhere (144) dealt with certain phases of the problem. We shall, however, review briefly the anthropological backgrounds of the South Europeans, then deal with mental differences, heredity and race stocks, and finally with a summarizing statement on hybridization and Americanization.

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[49] Cf: Young (143). In this study the writer described the disintegration of a neighborhood under the influence of modern industrialism. The personal attachments almost completely disappeared and neighborhood spirit practically vanished.

[50] Cf: (36) for report of neighborhood organization in Cincinnati.

A. The Anthropological Backgrounds.

Anthropologists are now prettly well agreed that there are today no pure races in Europe, using race in the strict sense. That striking differences exist between the sub-races, few deny. The older classification of European racial groupings gave three: Nordic, characterized by blondness and dolichocephalic head-form; Alpine, brachycephalic brunette type; Mediterranean, dolichocephalic brunette.[51]

i. The Italian Racial Origin. Italy as a whole constitutes a pretty anthropological problem into which we cannot go. It is now well-agreed that the basic stock of the Italian peninsula is much more homogeneous than writers of a generation ago imagined. Between North and South Italy, however, there are some quite marked divergences.

Ignoring the theories concerning the very oldest inhabitants of the peninsula, recent researches have revealed a civilization contemporaneous with the Aurignacian epoch in France from which some of the best Italian scholars maintain certain strains remain even today. Anthropologically, however, there has been no continuous line of racial growth. There still persist many difficulties unsolved. Pigorini, who has spent his life at these questions, believes that there was a time when suddenly in the midst of the older population appeared a "new people, whose usages, customs, arts and crafts" were totally exotic. Racially, too, these new-comers must have been a good deal removed from the indigenous folk. The following excerpts from Guiffrida-Ruggeri give the significant facts of the early settlers (48):

> These new inhabitants probably came originally from the East, in canoes, and having crossed the Mediterranean landed on the southern shores of the peninsula, as well as in Sicily and Sardinia. . . . They were a pastoral people and could in fact be no other than those who later came to be called Ligures (Liguri) by the historians. . . . The Siculi belonged evidently to the same race as the Liguri, and physically they were both people of the Mediterranean type. The most ancient neolithic population of Sicily, . . . must have come straight from the Eastern Mediterranean, probably from Crete. . . . The legend of the "Sicani-Iberi" invaders of

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[51] There has been considerable mixture of these three types all over Europe. Retzius (88) speaking of head-form, notes that all degrees from long-headedness to short-headedness exist in nearly every group of skulls or living groups examined by anthropometric methods in South, Central and North Europe. Such variation is found in pre-historic specimens (Neandertaler and others). Whether a given geographical area contains a long-headed folk or otherwise is a matter of relative frequency. Retzius shows that Sweden perhaps is the country of the purest North European sub-race, yet the proportion of dolichocephalic types to brachycephalic types, in Sweden, is represented by 87 per cent for the former and 13 per cent for the latter. Ripley (90) Ch. 10 shows that there is tremendous overlapping of types even in Italy. Cf: also (48).

Boas has pointed out (9) that overlapping is a characteristic among races in nearly every physical trait. It is also true of mental traits. It should be remarked in passing that the correlation between head-form and tests of intelligence is practically nil; cf: (25).

Sicily is now put aside. Similarities in the western part of Sicily to Iberian civilization are not lacking, but this is probably due . . . to "that great wave of influence which touched the coast districts of Western Europe, bringing with it the dolmen and dolmen-pottery" rather than to actual, large immigration.

These invaders are now credited with either an African or at least a Southeast Asiatic origin, different from that of the North European dolichocephalics. Sergi it was who first vigorously championed the African origin of the more immediate ancestors of the Mediterraneans. He does not think the race was related to the Aryans, at least in any near sense, but adopted the Aryan tongue. He says (97, p. 179):

> I affirm that the Italici, of Mediterranean origin, were forced through violent invasion to adopt the Aryan language.

A follower of Sergi writes (15, p. 30):

> The common ancestral home of the race has been placed, though there is no unanimity as to the exact locality, at the head-waters of the Nile, or at least somewhere south of the Sahara. This people is supposed to have crossed over into Europe by various points—Gibraltar, Malta, and Sicily, the Greek Islands, and Asia Minor—and spread over the whole continent as far as our own islands (British) and Scandinavia.

Whether the *meridioni* are actually of African origin or of Asiatic, via North Africa, is yet unsettled. It is significant, however, that there seems to be a shading off of this stock into the negroid types.[52]

The new inhabitants of Sicily and South Italy proper rose, under Mycenean and Ægean influence, to great culture and power.

Speaking in broad cultural periods, we may say that contemporaneous with the movement of the Mediterranean race, the races later known as Alpine and Nordic were moving toward Western Europe. In the sweep of the Alpine through Central Europe they avoided Italy, except in the north, where some of them coming over the Alps from the lake dwellings in Switzerland settled in the marshes about Venetia. The bulk of the population in North Italy, however, still remained the dolichocephalic brunette. Later with pressure of the oncoming hordes to the east, the descendants of the Alpine types pushed on south across the Po into Emilia and even in some instances over the Apennines. These peoples drove the older inhabitants before them to the south and it is probable that the later offspring of these dispossessed groups founded Rome. They did not in any likelihood reach beyond

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[52] Cf: (53, p. 159ff.). Johnson writes: "There is an ancient Negroid strain underlying the populations of Southern and Western France, Italy, Corsica, Sardinia, Spain, Portugal . . ." Cf: also Reuter (89) for a brief review of mixed-blood races. Kroeber (62) notes the fact of negroid strains in South Europe.

Latium. The brachycephalics who drove the forerunners of the Latins south became the Umbrians of ancient history. The Etruscans, who have long been an enigma (cf: 48, p. 329 and 90, ch. 10), need not detain us. The important thing at this point is simply that the shock of the Alpine invasion into the peninsula in the north scarcely affected Italy south of the Tiber.

So, too, the Teutonic invasions that came later. It is now generally thought that the various barbaric hordes that swept over the Mediterranean territories were neither excessive in size, nor always permanent in effect upon the big bulk of the indigenous peoples.[53] So far as the racial mixture went, it spent itself as Livi and modern anthropologists have shown long before it reached even South-Central Italy. Only scattered fragments ever extended to the "Toe and Heel" and into Sicily.

There went on, however, throughout the later historic periods accretion and racial mixture among the peoples of South Italy and Sicily. Freeman called Sicily "the meeting place of the nations." The Greeks in the classic period, then later than the "barbarian" invasion, the Saracens and Normans contributed something to the ethnic composition of the people. This has resulted in physical instability of type, and possibly instability of mental type, and gave rise to the further comment of Freeman, who wrote: "For the very reason that Sicily has found dwelling place for so many nations, a Sicilian nation there has never been."[54]

There are, in brief, two principal sub-racial stocks in Italy; but the basic one, even in North Italy, is the Mediterranean dolichocephalic. The Alpine influence is chiefly in the northern sections. The actual amount of Teutonic influence in the masses of the population is small. Today we realize that the invasions of the past were made by relatively small groups who were quickly absorbed in the native population, which altered only slowly. The ethnic displacement now seen in the Americas could only arise in view of modern transportation and industrialism. There is nothing analogous in history.

The immigration statistics inform us that 85 per cent of the

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[53] Cf: (90), Ch. 10, using data from Livi. Ripley is perhaps slightly more sympathetic to the older view that the Teutons influenced the population of Central if not Southern Italy.

[54] Quoted by Ripley (90), p. 271. It is significant that Sicily with its heterogeneity of peoples has not turned out a stable race. As we shall have occasion to note in a subsequent paragraph, the "melting pot" in one sense is a decided "myth." To produce a stable race, considerable isolation and inbreeding are necessary. Some of the advocates of a "free and easy" entrance of all "comers" into this country have the pious wish that out of this strange matrix will come ultimately a great people. They should peruse the history of some of these "cockpits of Europe," where the contact of racial stocks has been most violent and frequent.

Italian immigration of the last twenty years is from South Italy and Sicily. Its source is the lowest economic classes and in origin these people are largely Mediterranean with a noticeable negroid strain and other exotic mixtures. In the nature of their racial extraction we have a clue to their mental status. These anthropological facts furnish us with one probable cause of the marked differences between the children of these immigrants and those whose parents are of North European ancestry.

It must not be forgotten that this study is dealing with a sample of the South Italians and Sicilians, not with the peoples of South Italy and Sicily as a whole.

ii. The Portuguese Racial Backgrounds. The sources of the Portuguese immigration into California are three, and there are slight differences in the racial composition of each. These three are: (1) Portgual proper; (2) the Azores, Cape Verde Islands, and Maderia; (3) the Hawaiian Islands. The majority of the parents of the children we investigated came from (1) and (3).

The Portuguese belong to a sub-racial group which is closely allied in origin to the Mediterraean from which the sub-stratum of the South Italian population arose, but it contains even more negroid features than the latter. During the historical period the population of the Iberian peninsula mixed with the invaders from the North to some extent. Sergi comments (97, p. 162):

> Observations on the modern populations of Spain and Portugal have shown that, notwithstanding invasions from the end of the neolithic period and after the beginning of the age of metals, the primitive type of African origin has remained prominent.

The report of the Immigration Commission (51) informs us that most of the migration from Portugal proper to the United States is from Galicia and North Portugal, where the stock is probably somewhat more amalgamated with the Alpine and Nordic strains.[56]

The Portuguese from the Azores, Cape Verde and Maderia islands are all more or less recently mixed with African negroid strains due to the presence in these islands of much black labor. In the Azores there are some Flemish influences running back several centuries. The mixture with the Africans has probably not enhanced the native ability of the Portuguese stocks (21, p. 90). Furthermore the Azores were at one time a prominent penal colony for Portugal and the offspring of some of the penal colonists mixed with the remaining population. It would be a sheer guess as to the possible effect of this strain. However, the difference between the racial features of the Portuguese of the islands and the continent is not marked, and the differences if any are largely matters of degree of negroid influence.

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[56] There was some Moorish intrusion in historical times but the extent of the same is difficult to estimate. The best sources in English on the Portuguese immigration are (21, 93, 142).

Beginning about 1880 (68) the plantation owners of Hawaii, abetted by the Hawaiian government of the time, began importing cheap Portuguese labor from the islands just mentioned, and also from Portugal proper. At present they constitute the majority of the white laboring class in Hawaii. MacCaughey (68) has reported briefly on the racial mixture of the Portuguese with the various other races in Hawaii. While they have mingled rather freely, they have not significantly altered their racial characteristics. MacCaughey does remark, however:

> An appreciable percentage of Hawaii's population is more or less infused with Portuguese blood, as witnessed by the marriages of full-blooded Portuguese men and women with mates of mixed Portuguese blood.

In brief, while the Portuguese is not so homogeneous perhaps as the South Italian, he is basically of the same extraction.[66]

iii. The Spanish-Mexican Racial Backgrounds. Racially this group is the least homogeneous. In it were included a few subjects of apparently true Spanish origin, who came to California either directly, or via Hawaii. But the large majority of cases studied were of Mexican origin. It is generally conceded that the sub-stratum of the so-called Mexican population is Amerind.[67]

The racial origins of the Spanish peoples are much the same as the Portuguese and South Italians. It is unlikely that there is a marked amount of either Nordic or Alpine stock in the mass of the people. The modern population is literally descended from the very ancient ancestry. The slight amount of broad-headedness in the population of certain Northern districts shows Alpine (Celtic) influence. It is not extensive. On the whole, probably, the Spanish peninsula is racially even more homogeneous than any part of Italy, and especially more so than either North Italy or Sicily in particular.

In Mexico miscegenation among various racial elements has gone on since the very opening of the country by the Spaniards.

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[66] No attempt was made in the present mass study to segregate out the continental Portuguese from the islanders, or to classify according to possible negroid characteristics. A careful study of individual cases ought to take these matters into account.

[67] Cf: (56, 90, 92) Ripley, p. 464, mentions the homogeneity of the native Spanish stocks in the New World. Wallis (126) has written a brief paper on the Mexican immigrant in California which gives some facts on his temperament and economic status.

Since in the early settlements few Spanish women were found, there grew up a good deal of sex contact with native women. The Spanish and Portuguese seem never to have been opposed to miscegenation with the stocks with whom they came in contact. Moreover, besides the mixture of the Spanish and native Indians, the introduction of negro slavery into the New World brought a third factor into the situation. Today the class lines in Mexico reflect the race lines laid down a century and a half ago: At the top are the Spaniards and the Mexicans of preponderant Spanish extraction. These people constitute the wealth and political basis of the country. From these peoples the United States gets no permanent colonists. There is no secure middle class (though one is said to be arising), and the masses divide into groups according to the racial mixture:

> The civil position of every one depended mainly and naturally upon the greater or less whiteness of their complexion. "Todo blanco es caballero."
>
> Of the original elements which are blended in the modern population of Mexico from the contact of races, extending over a period of nearly four centuries, have arisen innumerable combinations which cannot be fully traced or classified. Thus the offspring of a European and an Indian is termed a mestizo; of a European and an African, a mulatto; of an Indian and an African, a zambo or chino (56, p. 220).

There are of course various intermediate grades between these and the process of mixture is still going on. Biologists and anthropologists both look with little favor on a violent mixture of races so divergent as some of these elements are. It is not impossible that part of the socio-economic difficulties of Latin America, especially Mexico, are due to the "character of an unfortunate hybrid race."

> Judgment as to the constitutional quality of this population should be reserved, however, until the conditions under which it has lived and developed have been carefully scrutinized. It is certainly important to try to appraise the Spanish-American stock, for there has never existed in historic times any such other experiment in the mixture of really alien races. . . . In its net results race-mixture plus other factors seems scarcely to have produced a favorable human type in Spanish-America; taken at its very best it has not represented a striking success (56, p. 219).

iv. The Racial Backgrounds of the "American" Children. This topic need not long detain us. The bulk of the ancestors of the children termed "Non-Latin" or "American" were English and German. There was a slight scattering of Swedish and Dutch, and a few Scotch. While even in the Nordics there is mixture with other stocks, the background of the North Europeans is pretty generally Nordic. The blond hair and complexion and tall stature of these children compared with the brunetness and stockiness of the Latins stood out prominently. There has been very little mixture of the Latin and non-Latin stocks in the sections of California studied. The contacts are too recent.[58]

B. Mental Differences, Heredity, and Immigrant Stocks.

The assumption was made at the beginning of this paper that there exists at present a good body of substantial scientific literature which proves that mental traits tend to be inherited as do physical characteristics, and that while not every factor that makes for successful adjustment in life is to be sub-summed under the category of heredity, that very much in the way of the fundamental physical and intellectual characteristics are carried in the hereditary germ plasm from generation to generation. It is not denied that environment, opportunity and accident play a varying role in the life adjustments, but without the potentiality of mental development that is innate, these other forces are of no great avail (35).

A second fact must be borne in mind. Mental differences, like physical differences, are matters of degree. Within the groups themselves the variability is greater than the differences between the separate races (120, p. 224). Hence the question of racial mixture of immigrant stocks becomes not one of one race with another, or of one sub-race with another sub-race, but of family stocks of various races. The present American population, barring all the accretions from Southern and Eastern Europe, contains a considerable percentage of strains of low mentality. While the average intelligence of the older stock is high, the range of abilities reaches from distinct feeble-mindedness on the one side to genius on the other. So with the New Immigration, one would not imagine keeping out any particular racial group as such. As Key puts it (59, p. 97):

> The vital point . . . would seem to be, not whether there has been amalgamation in a general sense, but what sort of amalgamation has resulted (from immigrant stocks). . . . Heredity studies are showing wide diversity in our native stocks, and it is a significant fact that, with incoming strains, those of low potentiality inevitably amalgamate with the lowest elements of our native population, while those of high potentiality amalgamate with the better elements.

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[58] For references on Nordics cf: (47, 90). Madison Grant's efforts to propagandize the Nordic view is unfortunate. His book is a mine of information and in the second, revised edition his footnotes and bibliographic references are very voluminous. What Grant fails to see is the fundamental fact of overlapping which holds throughout the comparison of all these groups,—physically and mentally.

Writing of race mixtures, Salmon states (96, p. 240):

> The component races must be virile and sound; they must not be too divergent; the new race must have a period of comparative isolation and inbreeding to fix its characters; occasional crossing with selected races of stock somewhat similar to the components should occur from time to time. There are excellent examples of the production of great races when these conditions have existed and there are examples of the pollution of very superior races when these conditions have been lacking. . . .

East and Jones say (35, p. 264):

> The hybridization of extremes is undesirable because of the improbability of regaining the merits of the originals, yet the hybridization of somewhat nearly related races is almost a prerequisite to rapid progress, for from such hybridization comes that moderate amount of variability which presents the possibility of the super-individual, the genius.

The point, then, of racial amalgamation in the United States is one concerning the type of abilities represented in the races going into the "Melting Pot." The desirable thing for any nation, as Galton pointed out, is a population possessing high average intelligence and considerable variability. This in conjunction with such breeding of the strains of better than average capacity would produce the men and women of above average ability who would not only carry on the cultural progress and thus continue to prepare the tools for the genius to work with when he appeared, but that also out of this high average and somewhat superior stock, through inbreeding, would come the individuals of very superior intelligence whom society terms "geniuses." It is, of course, biologically well known that through crossing of even mediocre or inferior stocks an occasional superior individual appears. But the chances for the appearance of such an exception are very greatly less than the chances that a real genius will arise from high average families, if they are kept uncontaminated from inferior mixtures (35).

We have passed the point of a careful selection of immigrant stocks in this country. We have already enough bad biological strains to serve as a menace to the best possibilities for a long time (22). Hybridization is taking place between the racial stocks in our country. That the biologically inferior tend *always* to mix with their kind, as Miss Keys maintains, is not so. The history of the Jukes, the Kallikaks, the Nams and others proves to the contrary. What is true is that consciously determined birth control on the part of the better elements in the population does take place when the economic opportunities mean that their offspring stand in danger of such serious competition with the less inferior as to lower the former's standard of living. It is precisely this fact that makes the problem serious. If the racial stocks that are flooding this country from Southern and Southeastern Europe are of such inferiority, on the average, as to be contented with a lower standard of life, if they are incapable of taking on the best of modern culture, then the sociological significance of the entire matter is apparent. Add to this the fact that amalgamation between these stocks and the older American stocks is certain to take place, and between different levels of average intelligence, we have a more serious phase of the problem presented us.

The writer does not undertake to say whether his findings are typical of the races from which the samples spring, but he does believe that they are very typical samples of the immigration that actually does come to this country from these old world countries. He has already noted that 85 per cent of the total immigration from Italy is from the same source as that from which the largest sample of Latins studied came. He is, however, cautious enough not to deny that environmental opportunities, as well as chance biological variations, may not in particular instances release latent possibilities in certain strains in these peoples in the future.

With the rapid incursion of racial stocks from Southern Europe has begun an inundation of our older population which will result in a racial amalgamation of possibly serious consequences. It is not a problem of the mixture of the Latins in general with the Americans, but of those classes of South Europeans and Mexicans of less average ability than our own American stock of the lower middle classes.

The writer has dealt elsewhere with the findings of other investigators on the problem of intelligence of immigrant children and has there summarized his own results (144). The discussion will not be repeated here. The up-shot of the work of others is to confirm the present investigation. The army results (73), the work of Dickson (31), Miss Thomson (118), Miss Roll (114) and Murdock (76), Brown (18) and the writer's study all indicate a growing body of information which must not be ignored by those who would have us admit all immigrants promiscuously in the pious hope that the future will wipe out present differences: economical, mental and social.[59]

If, however, the language handicap be thought all-important, we may dismiss the alpha results and taking beta, where no such accusation can be made, show that the Americans still far exceed the Latins. However, to ignore the verbal-test results is impossible so long as the correlation results indicate, as they do, a high relation between such significant outside criteria of intelligence and school success as grade location, teachers' estimates of school work and of general intelligence.[60]

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[59] Cf: also minor studies of (75). These latter were by means of unstandardized tests but are still confirmatory of the fact that the Italian immigrants do much more poorly than the Hebrew or North European immigrants. Cf: (106).

One question must be considered: Perhaps the general intelligence of the non-Latin group is higher than that of the typical "American" population. We saw above[61] that the "Americans" exceed the norms for their ages, and this may indicate that the sample of North European descendents studied is somewhat "above average" for their own group.

What, in conclusion, is the inference to be drawn from the present evidence? For the children of the racial stocks here investigated, a conservative answer must be that so far as this sampling goes, very wide differences exist. How much the difference is due to biological heredity and how much to environment is harder to answer. Extensive surveys have shown that mental abilities are, in large measure, inherited. One is justified from the scientific support of this point to conclude that the large part of the differences revealed in these measures *are* innate and hence reflect but the mental abilities of the family stocks and classes of the particular races from which they came.[62] In brief, the evidence presented seems convincing that marked mental differences do exist between the type of immigrant stock from South Europe that comes to this country and the older American stock. No generalizations are attempted for the Italians, Portuguese or Spanish-Mexicans as a whole.

C. Racial Hybridization and Americanization.

There is frankly no such thing as racial assimilation. There is only racial amalgamation (22). Assimilation implies that a parent stock may absorb another and make the second over to be like it. This is impossible. There is always hybridization. The resultant of a mixture cannot rise higher, biologically speaking, than the source of the lower of the strains going into the new product.

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[60] Cf: *supra* Ch. III, Pts. I and II.

[61] Cf: *supra* 34f. Had the writer omitted the two "best schools" in San Jose from his "American" group the differences would not have been so marked.

[62] Emotional and temperamental differences were not investigated. Science still lacks good measures for these, and must resort to composite judgments of persons if these differences are to be studied. The future will likely show us that emotional characteristics are fundamental drives to intellectual achievement, and divergences in races may be partially, at least, due to differences in emotional features. Cf: 79, p. 239-40, for comment on racial differences based really on these "non-intellectual" traits.

From the biological viewpoint the mixture of European stocks as *races* in the technical sense is not a problem in this discussion. The North European and South European are racially near enough together to inter-marry with no serious break-down of the effects of previous inbreeding (35, ch. 12). It is rather the matter of selecting the best of both stocks. And it must not be forgotten that the "Older Immigration" also brought its mental defectives and subnormals. But for today it is a question of relative numbers and of average variability of intelligence. The whole situation is well put by Conklin (22, p. 351):

> It is not the mixture of the blood of different European races in this country that should cause concern, but rather the amalgamation of superior hereditary types with those of inferior physical, mental and social traits, from whatever country or race they may come.

Our American policy of immigration should revolve around an appreciation of the significance of mental differences rather than economic. Two new points of view on the part of the public opinion and the legislative bodies of this country must come into being. The first concerns a changed attitude from quantity of immigration to quality, the second, the control of immigration in the interest of real national welfare and not immediate and partisan (*e. g.*, economic) exploitation. Restriction of immigration should go on in terms of capacity of the immigrants and not of their cheapness as laborers. A set of well-worked out physical and psychological tests with norms could be devised for a relatively slight cost which would be of untold benefit to the country's future in the way of preventing any further flooding of our country with low-grade materials on which to build a coming nation. We have enough liability in poor stock already without enhancing it.

The problem of Americanization is related to this entire question. While the cultural heritages from European sources must continue to be welcome to us, yes, even those brought over by the humble immigrants, our own cultural and civic values must be couched in such terms that they will connect with the Old World traits (79). Furthermore, in racial temperament the more removed European stocks may have great contribution to make to our own Nordic strains.

On the other hand, if such masses continue to come from the poorer biological stocks in Europe, as is apparently the case (5, 34) with much of our "Newer Immigration," the problem of cultural values may be immersed in lower standards of living, mental defectiveness and a general lowered toning of the best in our national life. The picture is not hopeless unless we leave it so. But our traditional social *laissez faireism* may result in serious consequences. But on the leaders and instigators of public conscience rest the duties of making evident the problem and pointing, after due consideration, to its solution. Our present muddling, however, will end in a social morass unless we do quickly make strides to free our minds of the popular and pleasing reasoning which is so dangerous.[63]

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[63] The writer refers to the existence in our country of certain false premises of equality of ability and a whole host of credos which are nothing but traditional rationalizations. The *real* reasons we avoid and enjoy the *good* reasons, since they are so much more pleasant to believe in. The latter furnish a basis for holding to the past; only the former provide a method of dealing sensibly with the future.

CHAPTER V. THEORETICAL IMPLICATIONS: RACE DIFFERENCES AND CULTURAL PROGRESS

The present-day discussion of the problems of racial differences and cultural progress make a short digression into the implications of the problem not out of place. This chapter will discuss theories of race differences and culture and an attempted interpretation of the problem.

A. Theories of Race Differences and Culture.

One discussion of racial mental differences which had great popularity in its day is typified in the writing of Gobineau (44), who held to the absolute inequality of races and believed the cultural progress of the world was doomed through the incursions of the inferior races upon the superior, ending in the final inundation of the latter by the former. He looked for the total destruction of the entire human race in ten to fourteen thousand years. After Gobineau followed a long train of writers who maintained that the world's population was segregatable into two or three races, with the white race at the top and the colored races at the bottom. Gobineau's theories may be truly termed pre-scientific.

The advancement of modern biology, anthropology and sociology has led to two trends in the discussion of these matters. The one point of view may be called, for want of a better term, the socio-anthropological, the other the psycho-biological.

i. The Socio-anthropological Standpoint. Ward (127, 128), Boas (9), Lowie (65, 66), Thomas (115, 116), and Park (79) may be taken as representative of the American adherents to this point of view. Ward was particularly opposed to the findings of Galton, and just before his death he made a last masterly thrust at the problem of race and heredity versus environment and culture (128). In this paper he maintained the view that so far as native ability is concerned, barring about one per cent of defectives and one per cent of exceptional geniuses, all mankind is equal and hence the important matter for cultural progress is, and always has been, environment and opportunity.

Boas is convinced that the mental differences between races are small, and that the overlapping in abilities is so great as to make any comment on extensive racial differences unwarranted.

He places his emphasis on cultural dissemination and the factor of time in cultural progress. Lowie, while possibly admitting some slight differences in the average mentality of races, sees in cultural borrowing the greatest factor in social advancement.

Thomas and Park, while admitting the place of the exceptional individual in invention and the development of techniques, are interested more particularly in the social attitudes and cultural products of races. The "run of attention" plus cultural opportunity are the important features. At least so far as the negro as compared with the white race is concerned they do not believe any very marked differences in mental abilities exist, nor would they likely admit much difference in native endowment between the present-day European peasants and primitive man, or between the social levels of modern society generally. Cultural opportunities rather than innate differences make for the principal differences in the levels of society or in race groups.[64]

ii. The Psycho-biological Point of View. The writings of Galton (42), Woodworth (137), Thorndike (120), and of the eugenists like Davenport (26) illustrate this viewpoint. Pearson (78) and his pupils represent the present followers of Galton in Great Britain.

Galton's writings on mental differences are well-known. While not believing in any such rigid differences between groups as did Gobineau, he maintained that the average intelligence of races differed. Moreover, very important was the fact that the variability of races differed, hence those groups that possessed the wider dispersion had the advantage in progress over another race of even like average capacity but of less variability.

Woodworth has pointed out that so far as the sensory-motor processes are involved the various races he examined seem to be much the same. He holds that what differences there are lie in the field of the higher thought processes, but that these differ only in relative terms and in varying degrees of magnitude. Thorndike contends that while differences in average intelligence may exist between races, the amount of variability within any group far out-reaches the differences in the averages between races as such.

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[64] Spiller (100), who represents these views abroad, writes: "An impartial investigator would be inclined to look upon the various important peoples of the world as, to all intents and purposes, essentially equals in intellect, enterprise, morality, and physique." Ratzel (87, p. 18-19) holds that the differences in races are due to "ethnography and civilization" and that "the study of comparative ethnology in recent years has tended to diminish the weight of traditionally accepted views of anthropologists as to race distinctions." Yet the facts of individual differences and overlapping can not be ignored.

Where differences appear he too believes them to be in the field of the "higher" mental traits. Culture, for Thorndike, must be the output of the superior individuals in a particular group. He further makes the point that not only variability and central tendency are important in racial advancement, but also the sheer size of any given racial group, because large numbers increase markedly the chances for the production of gifted persons.

These two standpoints have led at times to considerable controversy in scientific literature. The extremists in the first school can see little or nothing in racial differences, some of them even ignore individual differences within races. The more moderate of them have developed their technique for the study of culture and have usually held that by and large the cultural forces outweigh any other. They assume, then, that environment is much the most important force in human progress. The more extreme of the eugenists, on the other side, have denied any place to environmental forces and have written all human ills and wells in terms of hereditary factors,—physical, mental and moral. (Cf: 123, ch. 17.) The psychologists, however, along with the more conservative biologists, have had a place for the environmental aspects of progress, but have emphasized the mental and physical differences as arising principally in heredity. On the whole, however, they too have ignored the factors of cultural differences.

B. An Interpretation of Racial Differences and Culture.

Whatever controversy has occurred between the two points of view outlined above has arisen largely from a misconception of the relation of one set of factors in the situation to the other. One may for brevity say that there are two kinds of heredity: *Biological*, which carries the inherent capacities of the individuals from one generation to another (the laws of this inheritance are modifiable only in terms of the biological factors); *Sociological*, which is synonymous with the cultural products of the past that are carried from one generation to the next in education, techniques of food-getting, arts and science, and social organizations generally. The problem, then, of this chapter becomes one of harmonizing these two forces into a consistent scheme. The writer will put his interpretation forward under three phases: (i) the facts of mental endowment in races and individuals; (ii) the cultural or social heredity of groups; (iii) the present nexus between mental endowment and culture.

i. The Distribution of Mental Abilities. The studies directed toward facts about the mental abilities of the negro, the Oriental, the North American Indian, the immigrant groups in the United States and the results of the writer's own investigation all go to show that the abilities measured reveal differences both in the central tendencies and in the dispersion. As Thorndike points out, however (120, p. 234):

> There is much overlapping and the differences in original nature within the same race are, except in extreme cases, many times as great as the differences between races as wholes.

We cannot speak of superior or inferior races. We must think of them as groups all possessing individuals running from what we term feeble-minded to gifted if not geniuses. But the *relative percentages* of these and the variability around a given average may differ considerably. Moreover, facts of size of a given population, of inbreeding and outbreeding and especially of selective breeding among the better strains are important.

It follows from this that, on the whole, the chief matter of mental differences is that of relative amounts of differences within the races themselves, and second, the possible effects of inter-mixture with other races of lower central tendency and less dispersion depends upon whether the superiors of both undergo miscegenation, or the mass of the inferiors swamps out the best of the higher average group.

In terms of race progress the existence of individuals of above average or superior ability is the first essential to inventions and creations that make for advancement. The capacity for conceptual thinking is the core to improvement in the arts and sciences. Now there is considerable evidence that superiority of general native intelligence is measured in terms of the capacity for the "long-shot" use of free imagery, abstract symbols, seeing of remote meanings and relations in natural and social phenomena. In fact there seem to be actual levels of development of thinking ability which are uninfluenced by the state of environment (46, 102). True enough, "accident" and attitude play a role, but it is idle to deny the tremendously important place that superior individuals have served in mechanical inventions, in social inventions,—institutions, religious, economic and political; in artistic creation,—myth, literature, the fine arts; and lastly, in science, objective methodology and standpoint. In brief it may be stated that progress rests firmly upon individual mental endowment.

ii. The Distribution and Importance of Culture. The particular level of culture to which a group has attained may be due either to the progress of the group itself, which means a peculiar blending of superior individuals and crises[65] in development or to cultural borrowing. Just as at present in the study of mental differences, it is often perplexing to attempt to segregate the factors of heredity from those of environment, so in ethnology the amount of borrowing as against the amount of originality in a given culture is extremely hard to determine. Moreover, there is scarcely a case extant of pure borrowing. The recipients of outside cultural favors usually alter the details, adding or subtracting therefrom to suit their own needs. Sometimes they improve considerably upon the device, be it social or mechanical. The extent of the improvements again will depend upon the existence of individuals who are able to see in the borrowed products cues to further extension of their usefulness. Thus has technique and attitude toward improving inventions and creations arisen, and the progress of a group may be said to depend upon the presence of above average ability in the group as well as to the mere fact of borrowing.

Therefore, social heredity of a given race of either superior or inferior average ability may include a great deal that is exotic in origin. Recent researches have shown that the Greeks, for example, who stand without peers both in intelligence and cultural contributions of their own, were far greater debtors to more ancient cultures than older scholars ever dreamed. On the other hand isolated races like the Central and South American Indians developed interesting cultures of their own. Their art and technique was as distinctive as it was original. The Melanesians and Polynesians also developed independent cultural areas. The Japanese, a people of apparently high average intelligence, have long been extensive borrowers, usually improving, adapting and using these contributions for their own-benefit.

In science and mechanical technique the processes are very noticeable. Man in his effort to control and combat natural forces around him has been both inventor and borrower. The state of the technique and the social attitude of the group must go together to produce advancement. Take the case of modern science. Its present freedom and importance are young. For centuries it lay dormant and undeveloped under the weighty hand of creed and superstition. So in primitive groups, the power of taboo and ritual in preventing the curiosity of the individual from penetrating the mysteries of natural or social phenomena were great deterrents to the development of objective techniques and attitudes. At best the able individual's mental development acquired the content laid down by the group attitudes. He put his capacities to work where the group permitted. As some one has said, although a Newton could hardly contribute a system of physics if born a Hottentot, he nevertheless would have been the most gifted mentality in his group and might have led his people to success in warfare or other progress which their cultural background made possible. *The particular line of attention which the superior persons in a group adopt is determined by the state of the social heredity.* Even to this day investigation into social behavior and the human mind has to combat popular superstition and ignorance. It is simply the modern chapter of folkways and mores operating against objective science.

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[65] Cf: Thomas (115) on crises. The term "crisis" is used in the broad sense of any critical situation demanding attention and solution. They are the new features of environment to which the individual adjusts, and his measure of success is largely in terms of his native capacity operating through the cultural tools that make up the contents of "mind."

Without going to great length the writer does wish to emphasize the place that convention, tradition, mores and subjective social controls have played in the matter of human progress. The history of science and of civilization is replete with instances of the blocking of progress by the social attitudes of the group backed by the authority of priesthood, cult and caste.

iii. The Present Use of Heredity—Mental and Social. This is the important feature of the entire question. Present-day inquiries about racial progress, racial mixture, democracy and the future of science hinge upon it.

One must not forget the cumulative effect of modern progress, that with every advance, in any direction,—art, science or social invention,—there goes additional stimulation to the rising minds to attack and prolong the process. Herein lies a curious thing in modern developments and possibly one noteworthy cue to its solution. We have the "set" or attitude of progression much more consciously expressed than ever before in history. Never previously have groups so large as the European, American and Far Eastern world moved almost in unison in terms of cultural ambition. This attitude, this desire to "get on" ramifies every avenue in life. It may be that just now our interests are pointed toward economic exploitation especially; but whether narrowly economic or more truly "social," the attitude is everywhere about us. It is inescapable, and today among all classes practically, and among the foremost nations, the one dishonor is not to be "going somewhere."

Modern means of communication have enhanced tremendously the possibilities of inter-stimulation among minds. We consciously create "crises" and stimulation in our preparation for life that simulate those in actual later accomplishment. Coupled with these facts is the present expansion of numbers of the population, which as we have seen increases the probabilities for the production of gifted individuals. It is not known whether the relative number of gifted individuals and particularly geniuses is greater or less today than in Plato's and Aristotle's time. Galton thought much less. It does not, perhaps, matter. The fact of numbers, modern science and communication in cultures probably offsets the differences imagined by Galton if they exist. It does concern us, does it not, whether the average intelligence of our race is decreasing and the range of variability growing narrower. Are we headed for a definite, unpreventable regression to the mediocre? A hypothetical case will put the problem before us:

Suppose that all class A chemists, men of superior and above average native ability, should be wiped out at one stroke; the class B men would still be capable of continuing important research after some fashion. With the present technique at hand, worthy discoveries and valuable applications would still be made. But does anyone doubt that ultimately chemical progress would be slowed down so as to affect all scientific progress related to it, as well as its own, unless new men of class A ability came into the field?

Another point: Cultural borrowing is going on apace now more than ever. Little does the man in the street realize the place that superior abilities have had in making his comforts and conveniences, and enlarging his grip on the universe. However, *the capacity to use and derive benefit from any given invention or idea is a vastly different thing from the initiation of the idea or the consummation of the invention.* For instance, a moron may be able to read a thermometer with sufficient intelligence to enable him to do simple tasks such as opening or closing the windows of an office or school building. It is a different matter, first, to have the capacity for the education which enables one to master the laws of physics and chemistry relating to the expansion of mercury in the presence of heat. Moreover, to be the first individual to work out the laws of the expansion of mercury is even more unusual both in terms of opportunity and native capacity well trained. Again a man of less than average intelligence may successfully manipulate a truck over the ordinary traffic routes of a city, but may not be able to repair the engine of the truck in case of trouble. Neither may the repairman be able to think up new devices for gas engines or more remotely to figure out the relation between the expansion of certain volatile substances and the application of the phenomenon of gas expansion to motive power.

Hence, though modern society has well begun to eliminate the most serious handicaps to progress in the way of taboo and creed on the one hand, and has under science developed communication and objective attitude, the essential fact remains that the continued initiation of progress depends upon the use of and gradual accretion to this social heredity by those of above average ability, who breeding their kind in a selective fashion will lay the biological chances in such a way as to produce the very gifted individuals in each generation who will lead this progress most significantly forward. Any racial mixture that will hinder this, or affect it negatively, by so much is destructive of the best possibilities of the best strains of ability wherever found.

iv. Summary. In conclusion it may be re-stated that the intelligence of groups and races is important, and any change in the percentage of high average intelligence and a wide variability giving superior members in one group or race through mixture with less intelligent (on the average) and less variable stocks will slow down the cultural advancement possible for the given group.

Second the differences in cultural opportunities in various classes of any population, or races, are rapidly disappearing through the application of modern science to the spread of culture. The most consequential aspect of the culture is the degree of scientific techinque and the state of the arts developed in connection with the social attitudes toward the use of these possessions.

Third, the future lies with the preservation of the best average intelligence in the entire population possible, coupled with the widest varibility toward the superior deviates.

Finally, an ethical implication of all this must not be overlooked. It is precisely here that the features of culture and the attitudes or social values are of primary importance. Whether the progress of Western civilization is to go forward in terms of a more just and ethical social organization, giving place to well-integrated personality and high culture, or whether it is to go to the extreme in machine technique and increasing routinized industrialism without any general social benefits to the masses, all the while breeding nationalistic jealousies that lead to war and inventions of ever newer and more ghastly methods of warfare, depends upon the education and the social ethics which the intellectual leaders of society acquire. Our modern world must accept the best in culture, no matter its exotic origin; we must continue our emphasis upon the dispelling of prejudices. And before all else equal opportunities must be accorded every child and adult for the accomplishment of the best his capacities allow. It is barely possible, to say the least, that the integration of personality which this implies may revolve around considerably different values than those now insisted upon.

In the groups whose mentality has been studied, the range of ability in all runs from high to low. Although some groups decidedly outstripped others on the average and in variability it does not follow that the less fortunate groups are not capable of the use of culture or that their groups do not contain persons who are capable of superior attainment. Society must provide for the utilization of the best abilities from all races and classes as well as the use of the corresponding cultures. Therefore, the problem of racial difference especially so far as it touches the European groups, and presumably the Orientals too, is not an ''all or none'' principle, but one of relativity and proportion. Let our segregation be along the lines of ability, never of race as such, and with the proper opportunities for all, especially for those capable of leadership, the future of culture itself is secured.

CHAPTER VI. GENERAL SUMMARY AND CONCLUSIONS

A. The Purpose of This Study was: (1) to investigate the general intelligence of children of certain immigrant stocks to discover, (a) whether the alleged language handicap in their school progress existed in fact or not; or (b) whether the difficulty with their school attainment were due to deeper lying causes in their native mental endowment; (2) at the same time to secure facts on the mental differences in the racial stocks studied. The assumption was made that general intelligence is measureable, and that it is to a large extent inherited, and is not greatly altered by the adventitious character of a particular environment; that is to say, not altered in form and potentiality, only in content.

B. The Methods of Approach consisted in: (1) the use of several outside measures of ability of the groups in question: (a) teachers' estimates of (i) general intelligence and (ii) school work; (b) grade location; (c) parents' occupational levels: (2) the giving of two types of psychological tests of general intelligence: (a) a verbal test, army alpha, and (b) a non-verbal test, army beta.

It is believed that the comparison of the results of these two tests, first through their measures of averages, dispersion and overlapping, and second, by means of correlation methods would throw light on the question not only of the native intelligence of the children tested but also answer specifically the question of "language handicap" versus native endowment as the most important cause of school retardation. The tests would also serve to throw light on the query concerning mental differences in these racial groups.

(3) Rather than selection of children by grade, a common chronological age of twelve years was taken, in choosing the sample.

(4) The anthropological backgrounds of the racial stocks were briefly reviewed for purposes of partial interpretation.

C. The Data as collected and subjected to statistical treatment disclosed the following facts:

(1) Extensive retardation of the Latins as compared to the Americans.

(2) The teachers' estimates of school work indicated that in their judgment the Latins do considerably poorer, for their grades, than the non-Latins. The latter exceed the former, in terms of mean rating, by an amount equal to nearly one-seventh of the range of the scale upon which the ratings were made.

(3) The teachers' estimates of general intelligence showed that the non-Latin C. T. exceeds that of the Latins also by one-seventh of the range of the rating-scale. Both ratings of school work and of intelligence indicate that the Americans are more variable, in the judgment of their teachers, than the Latins. None of the latter reach the classification ''Very Superior'' on either scale: school work or intelligence, while the percentage of Latins labeled ''Very Inferior'' greatly exceeds that of the non-Latins in this category, for either scale.

(4) Grade location indicated that on the average the Americans excel the Latins by nearly two grades. If the present grading is anywhere nearly just and 100 I. Q. can be taken as the average for the Americans in terms of present grade status, the Latins are five-sixths of this amount and might be represented by an average I. Q. of 83.

(5) The economic status of the parents of the children shows that there is a rough relation between economic class and the mean intelligence of the children of these classes. While there are bright, median and dull intelligence in each classification, all abilities from high to low exist in each class, but in varying degrees of frequency.

(6) The psychological tests results show:

a. That very wide differences exist both in C. T. and in dispersion between the Americans on the one hand and the Latins on the other. The overlapping, corrected in terms of the reliability of the tests disclosed the following:

i. For the Alpha, the upper 50 per cent of the Latins scarcely exceeded the lower quartile of the Americans, while only from 5 to 7 per cent of the Latins exceed the median of the Americans, and but 1 to 2 per cent exceed the upper quartile of the latter. There is good evidence that the alpha is the better of the two tests in terms of its differentiating value, but if this be not admitted, the beta results, themselves, show very striking facts of overlapping. Only from 11 to 16 per cent of the Latins exceed the median of the Americans in beta, from 25 to 30 per cent exceed the lower quartile of the latter, and but 4 to 7 per cent the upper quartile. Since the beta is clearly inadequate to differentiate among the superior, average and low average in the American groups, were the beta more difficult the results would have been more nearly like those in alpha. As might be expected the alpha and beta combined together in one scale give an overlapping somewhat between the two extremes of alpha and beta alone.

This evidence constitutes proof of the decided inferiority, on the average, of the Latin stocks to the American group studied. It likewise has its relation to the matter of racial differences in mentality.

b. The correlational materials present further answer to the problems of the study:

i. The verbal test—alpha, proves a better measure of the ability of the Latin groups than the beta, which shows:

ii. That the alleged language handicap does not exist to anything like the extent usually supposed. While in the case of the Spanish-Mexicans the beta seemed to be about as adequate for diagnosis as alpha, it was not markedly better, and the best evidence from an analysis of the test results would indicate that had another verbal test more commensurate with the general level of intelligence of this group been employed it would have served better to measure educability and for use in grading than a nonverbal.

It is not denied that language difficulties play no part whatever in the problem of the immigrant's child, but it is a minimal matter compared to that of native endowment. The correlation of alpha against grade location with the Italian 12 year-olds who were born in Italy was five points higher (r .76) than the beta against grade (r .71). While the beta compared more favorably with alpha in this case than in the general sample, it is noteworthy that the alpha is still better as measured by the best single outside criterion of educability (and thus of intelligence) that we have.

Therefore, the conclusion is put forth than the language handicap of the children in the public schools is not the cause of the difficulty with the school materials. Retardation is in terms of native capacity.

iii. The results of the tests, both alpha and beta, when correlated with the occupational status of the parents, show that some slight correlation exists between the mental standing of the pupils in these tests and the economic success of the parents as measured by the occupational classifications used. The correlations, however, are not high enough to warrant conclusions concerning the probability of a given intelligence falling in a particular occupational group.

D. The significance of these findings for the educational-administrative program include briefly the following principles:

(1) Alteration in the educational point of view recognizing the fundamental need for differential education for the various levels of capacity in school population. The more specific changes will involve:

a. Alteration in administrative and supervisional organization looking to:

i. A plan for re-grading school populations in terms of mental age rather than chronological.

ii. Grade organization providing for at least three levels of school work—for the superior, for the average and for the backward. In addition, increased provision will have to be made for the feeble-minded, of whom such populations contain considerable numbers.

iii. The wide, but proper use of pedagogical tests and measurements for periodical checking up on the efficacy of the educational product.

iv. These last three important points necessitate the establishment of a research bureau, with a director trained in administering and interpreting psychological and pedagogical tests for school uses.

b. Changes in the curriculum will be necessary.

i. The principles of curriculum making must be clearly understood, i.e., the objectives of education must be defined.

ii. Differential materials and methods must be made a part of the course of study to fit the levels of capacity of the pupils, and their future requirements in adult society.

c. Teaching methods need serious revamping. The project method of education will find an excellent place in this scheme. Contacts with the outside industries and occupations will need to be made.

d. If immigration continues to give the public schools newcomers from abroad, special provision must be made to care for the immediately arrived foreign-born children and adults in the matter of acquainting them with the tools of English. When they have acquired sufficient English they may be shifted to such grades in the regular school as their capacities demand.

e. The public conscience and public co-operation must be enlisted to make this school policy go. Neighborhoods must be revived and the school must become the center of the social life of the families who group themselves around it.

E. The findings of the thesis are also important for the problem of immigration and race mixture. It is not maintained here that the intelligence uncovered in these groups is typical of the entire racial groups from which the sample sprang, but it is held likely that it represents very well the common run of immigrants from these countries who do actually settle in the United States. Other studies corroborate the findings of this investigation and lend credence to this belief. Therefore, the importance of the matter for immigration and national future.

While the European races are probably all of near kind, the South Europeans have considerable negroid strains in the masses of the people and this fact may, in part, account for the divergence from the intelligence of the North Europeans' descendents. On the whole, however, the theoretical as well as practical problem of the European in this country is one of relative degree of native intelligence in the groups as compared to that of the older American stock. And the question of racial differences and the country's welfare is one of such public policy as will give the future the best of all the strains present and prevent such amalgamation of inferior with average and superior as will lessen the average intelligence of the nation and narrow the dispersion of abilities toward the production of gifted individuals.

Certain theoretical features of race differences and cultural progress were made. These are necessary implications for the wider meaning of this investigation.

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FOSSIL FRESHWATER MOLLUSKS FROM OREGON

Contained in the Condon Museum of the University of Oregon

BY

G. DALLAS HANNA

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FOSSIL FRESHWATER MOLLUSKS FROM OREGON

INTRODUCTION

The University of Oregon possesses a collection of fresh-water fossil mollusca which was assembled by the pioneer geologist of the state, Prof. Thomas Condon. While his interest was chiefly centered in the vertebrates, he collected a considerable amount of material in other groups as well. The writer has already reported upon the collection of fossil land shells made by him,[1] and it is through the courtesy of Dr. Earl L. Packard of the Department of Geology of the University that the results of a study of the freshwater forms is here presented.

The collection contains 21 lots of material, chiefly from supposed Pliocene deposits in the vicinity of Warner Lake in the eastern part of the state. One lot, however, appears to be of Eocene age and three have been recorded from the Pleistocene. It must be explained, however, that the last age determination was made with grave doubt as to its correctness because we know nothing of the stratigraphy of the deposits involved. The basis was solely the presence of the genus *Carinifex* in the material. It may have been accidentally excluded from the other lots since each one consists merely of a block of the material as it existed in place. No attempt was made in the collecting to secure a full representation of the species at any locality and as a consequence some of the most remarkable forms are represented only by fragments. Undoubtedly many more, not here recorded, exist at the various places and the field is one which offers great possibilities to the trained collector of fossil shells.

One notable feature connected with every locality is the absence therefrom of any species of the genera *Lymnaea* and *Physa*. Whether this is merely due to the manner in which the collections were made or whether these widespread groups actually did not exist in those ancient Oregon lakes can of course not be stated until further field work is done. The absence of all Unionidæ is also noteworthy.

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[1] **Hanna, G. D. Univ. Ore. Pub., Vol. 1, No. 6, pp. 1-8, pl. 1, 1920.**

DESCRIPTION OF SPECIES

GENUS: PLANORBIS MÜLLER

SECTION PARAPLANORBIS HANNA, NEW SECTION

Whorls rounded on the periphery as in *Helisoma* Swainson but aperture not expanded, umbilicus very narrow and size minute.

Type, *Planorbis (Paraplanorbis) condoni* Hanna, new species.

PLANORBIS CONDONI, N. SP.

Plate 1, figures 1, 2, and 3

Shell, planorboid, composed of about 4½ regularly increasing whorls; apical cavity a cone of about 120 degrees. Last whorl slightly angulated about the upper margin and descending slightly at the aperture. Lines of growth fine and even, giving the shell a silky luster. Umbilicus deeply rimate, .51 mm. in diameter. Aperture roughly triangular but rounded on the outer lip; not expanded or thickened but a depression both above and below the periphery. Diameter, 2.67 mm.; altitude, .35 mm.

Type, No. 14 University of Oregon. Cast of same No. 671, Mus. California Acad. Sci.

Type from University of Oregon, Locality 212. Vicinity of Warner Lake, eastern Oregon. Pliocene.

This little shell is unlike any other known to me; it could not even be placed in any of the sections of the genus *Planorbis* as defined by Dall, a late summarizer.[2] In the narrow, deeply reamed umbilicus it resembles the section *Hippeutis* Agassiz, but the whorls are not planulate on top or carinated on the periphery. No lamellæ were found in the aperture, thus excluding it from the genus *Segmentina* which it somewhat resembles.

The species is not common, only three specimens having been found in the deposits about Warner Lake. These display almost no variation from the type described above, except in being somewhat smaller and younger.

PLANORBIS (TORQUIS) SCABIOSUS, N. SP.

Plate 1, figures 4, 5 and 6

Shell similar in size and shape to *Planorbis parvus* Say, but has more whorls for the same size. Whorls increase in size less rapidly and they are more nearly circular in cross section. The apex is slightly depressed below the plane of the whorls. Last whorl not depressed at the aperture and aperture not expanded. Umbilicus regularly formed, a little narrower in shells of the same size than in *P. parvus*. The most conspicuous difference is in the lower margin of the aperture. In *P. scabiosus* this leaves the junction of the body whorl in a direction almost at right angles to the diameter of the shell while in *P. parvus* the line is only about 30 degrees from the horizontal. This makes the depth of the aperture in proportion to its breadth much greater in *P. scabiosus.* Diameter, 3.4 mm.; altitude, 1.1 mm.

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[2] Dall, W. H. Harriman Alaska Exp., Vol. 13, p. 80, etc. 1905.

Type, No. 15 University of Oregon. Cast of same, No. 678, Mus. California Acad. Sci.

Type from University of Oregon locality 212. Warner Lake beds, eastern Oregon. Pliocene.

In the shape of the whorls this little species differs from all other species of the small planorbs known to me. The sculpture consists only of fine regular growth lines but this is somewhat obscured by limy incrustations which suggested the name. The species is not rare at the type locaity, about a dozen specimens having been found.

GENUS: PARAPHOLYX HANNA, NEW NAME

Pompholyx Lea, Proc. Acad. Nat. Sci. Phila., Vol. 8, p. 80, 1856. Type, *Pompholyx effusa* new species. Lea, Journ. Acad. Nat. Sci., Vol. 6, p. 156, pl. 23, fig. 69, 1866.—Dall, Proc. Calif. Acad. Sci., Vol. 3, p. 265, 1866. (Describes new subfamily, *Pompholinae,* possibly new family, *Pompholidae.* Figures and description of external anatomy of soft parts.)—Binney, Land & Fr. Water Sh. 2, Smith, Misc. Coll. 143, pp. 73-4, fig. 119, 1865. (Two views of type specimen.)—Dall, Ann. N. Y. Lyc. Nat. Hist., Vol. pp. 333-340, 1870. (Uses name *Pompholiginae* for subfamily including *Pompholyx, Carinifex* and *Choanomphalus* (?). Not *Pompholiginae* Dall, Proc. U. S. Nat. Mus., Vol 23, p. 814, 1901, a section of the marine genus, *Divaricella.*)—Hannibal, Proc. Mal. Soc. Lond., Vol. 10, p. 162, 1912.—Walker, Univ. Mich. Misc. Pub. 6, p. 14, 105, 1018. Not *Pompholyx,* Gosse, Ann. Nat. Hist., Vol. 8, p. 203, 1851, a genus of *Rotifera.*

When Lea established the genus *Pompholyx* for the West American fresh-water shell he evidently was unaware that the same name had been previously used for a genus of rotifers. A search of available literature fails to disclose any other name that has been substituted for the mollusk; therefore the new name *Parapholyx* is proposed with the same type species, *Pompholyx effusa* Lea. *Pompholopsis* Call (Type, *P. whitei* Call)[3] was proposed as a subgenus of *Pompholyx* to contain a species found in the Tassajara Lake Beds, California. While it doubtless belongs to the same family as *Parapholyx* it is not believed to be congeneric and is therefore not available to replace the preoccupied name. Call states that the specimens of *Pompholopsis whitei* were deposited in the collection of the University of California at Berkeley but a search conducted therefor by Professor Bruce Clark has been without success.

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[3] Call, R. E. Am. Geol., Vol. 1, p. 146, vgs. 1-3. 1888.

PARAPHOLYX PACKARDI, N. SP.

Plate 2, figures 1, 2, 3, 4, and 5

Shell, large and robust, composed of about 3½ whorls which increase rapidly; suture deeply impressed around the last whorl, the depression almost amounting to a channel. Spire elevated but apex flattened and smooth. The shell is otherwise coarsely sculptured, the second whorl being marked with even ribs but these are gradually obliterated toward the aperture. Aperture, auricular, pointed below and thickened within; columella parallel with the axis and bearing an obtuse tooth at its center. Umbilicus closed by a deposit of callous material; when this is broken away the perforation is found to vary from almost nothing to about two millimeters.

MEASUREMENTS

Diameter	Altitude	
15.4	13.2	(Type)
13.7	11.4	
14.0	11.3	
17.6	13.9	
19.5	17.1	
17.8	15.5	
5.5	6.0	(Fresh shell from Locality 213)

Type, No. 16 University of Oregon. Cast of same, No. 672, Mus. California Acad. Sci.

Type from University of Oregon locality 212. Warner Lake Beds, eastern Oregon, Pliocene.

This and *Valvata oregonensis* are the most abundant species collected at locality 212. Large numbers of the shells are loosely cemented into a mass which has very little admixture of foreign material. Great variation is exhibited in the series studied, the above description, with the exception of the last phrase, being applicable to the type specimen only. It however represents the most common variation. Some specimens are a little more bulbous in the last whorl; in some the ribbing continues to the aperture and in some the ribbing is replaced by malleations. These variations in sculpture have sometimes been attributed to saline waters.

GENUS: CARINIFEX BINNEY

CARINIFEX, SP.

At locality 210 and possibly 212 there are fragmentary remains of a species of the genus *Carinifex* which cannot be identified with any known form. The species is characterized by its very narrow umbilicus but it is not here given a name because none of the specimens seems sufficiently well preserved to warrant this action. Some specimens grew to huge size, almost two inches in diameter. The species seems to be closer related to *C. ponsonbii* Smith, which I believe to be restricted solely to Klamath Lake at present, than any other but differs chiefly in having a much narrower umbilicus.

GENUS: VORTICIFEX MEEK

Vortifex Meek, Proc. Acad. Nat. Sci. Phila. 1870, p. 59. Type, *Carinifex (Vortifex) tryoni* Meek, new species. Proposed as subgenus of *Carinifex* Binney.

Vorticifex Meek, Ann. Lyc. Nat. Hist. N. Y. Vol. 9, p. 353, 1870. Correction of *Vortifex,* originally misspelled. (Vide Scudder, Nomen. Zool. Bull. 19, U. S. Nat. Museum, p. 352, and pt. 2, p. 335, 1882.)

Vorticifex Meek, Tryon, Am. Journ. Conch. Vol. 6, pt. 3, p. 285, April, 1871. Review of Meek's paper. *Vortifex* corrected to *Vorticifex* and *Carinifex tryoni* stated to be the type.

Vorticifex Meek, U. S. Geol. Surv. 40th parallel, Vol. 4, p. 187, 1877. Subgenus described and *binneyi* and *tryoni* both placed therein.

Vorticifex Meek, Call, Am. Geol. Vol. 1, p. 148, 1880. Genus formally described and *Carinifex binneyi* Meek designated as type, but wrongly.

Vorticifex, Dall, Harriman Alaska Exp. Vol. 13, p. 63, 1905. (A modification of *Carinifex* due to lake waters becoming alkaline.)

This genus was proposed by Meek for some shells which were collected in Nevada by the U. S. Geological Survey under Clarence King. Authorities have differed somewhat in the designation of the type species but I think there can be no question that *V. tryoni* is the proper one. Meek named two species and two subspecies but later consideration led him to suspect that all were the same. His original material seems not to have been subsequently studied nor does it appear that any collector has revisited the type locality. The chief distinguishing features of the genus are (1), lack of carinæ, either at periphery, suture or around umbilicus; (2) much rounder body whorl than *Carinifex;* and (3) much less triangular aperture than *Carinifex.* The following are the names which have been assigned to the genus: *tryoni* Meek, *tryoni ventricosa* Meek, *tryoni concava* Meek, *binneyi* Meek, and *condoni,* new species. In addition to these there are certainly two others represented in the eastern Oregon deposits now under consideration but the specimens are too fragmentary for description or naming.

VORTICIFEX BINNEYI (MEEK)

Plate 4, figures 6, 7, and 8

Carinifex binneyi Meek, Proc. Acad. Nat. Sci. Phila. 1870, p. 59. "Fossil Hill, Hotspring Mountains, Idaho Terr. Apparently of Miocene or later age."

Carinifex (Vorticifex) binneyi Meek, U. S. Geol. Surv. 40th parallel, Vol. 4, p. 187, pl. 17, figs. 11, 11a, 1877. Locality corrected to "Fossil Hill, Kawsoh Mountains, Nevada."

Vorticifex binneyi Meek, Call, Am. Geol. Vol. 1, p. 148, fig. 6, 1880. Formal description of genus *Vorticifex* given and the species *binneyi* cited as type but this action was untenable as explained elsewhere.

Carinifex (Vorticifex) binneyi Meek, White, 3rd Ann. Rep. U. S. Geol. Surv., p. 448, pl. 32, figs. 5, 6, 1883. General account of the species and its locality.

Pompholyx (Carinifex) binneyi Meek, Hannibal, Proc. Mal. Soc. London, Vol. 10, p. 163, 1912. Recorded from "Eocene: Truckee Lake beds, Nevada; Payette Lake beds, Idaho."

Shell large and robust, composed of 3 to 4 whorls, apex slightly raised above plane of body whorl. Suture usually channeled;

aperture not greatly expanded, roughly triangular in shape but rounded at the outer and basal angles. Umbilicus about one-fourth the diameter of the shell. Surface marked with lines of growth, low even ridges or malleations. Diameter, 17 mm.; altitude, 9.4 mm.; width of umbilicus, 4.5 mm.

The above description is based upon a good series of specimens from University of Oregon locality 210, from the vicinity of Warner Lake, eastern Oregon. While the majority of the shells have a higher spire and a narrower umbilicus than Meek's description and figure show, these variable characters seem an insufficient basis for the creation of a new species at this time. Material from the original locality of *binneyi* is very badly needed for comparison because Meek himself came to doubt the distinctness of the widely and narrowly umbilicated forms he described from the same deposit. Should they prove to be the same, *binneyi* will take precedence, having page priority.

This species cannot stand as the type of *Vorticifex* as Call has placed it because Meek used the subgeneric name only with *tryoni.* It probably was his intention to have it apply to both species because he later so used it; nevertheless he did not do so in his original description and no construction can be placed upon his original phrases to show that he intended *binneyi* to be in *Vorticifex.* In his review of Meek's paper Tryon considered *tryoni* as the type of the new subgenus, if priority in designation be desired.

Hannibal has united both species and records them from the Eocene, a very doubtful occurrence. I have not seen authentic specimens of either but Meek's descriptions and figures certainly do not indicate that they are the same. He had a good series of specimens but did not find intergradation.

Cotypes are No. 12,542 U. S. Nat. Museum from Kawsoh Mountains, Fossil Hill, Nevada.[4]

VORTICIFEX CONDONI, N. SP.

Plate 4, figures 9 and 10

Shells composed of 3¼ whorls, the nuclear 1½ smooth and polished. Next whorl after nucleus with 10 high ribs which continue with slightly lessening space between to the aperture. Suture well impressed but not channeled. Apex raised but very little above the plane of the body whorl. Periphery, rounded. Umbilicus wide, exposing whorls to the apex, a little more than one-third as wide as the greatest diameter of the shell. The base of the shell is obtusely angulated at the mouth of the umbilicus. Diameter, 4.4 mm.; altitude, 2.1 mm.

Type, No. 17 University of Oregon. Cast of same, No. 675, Mus. California Acad. Sci.

Type from University of Oregon locality 212, Warner Lake Beds, eastern Oregon. Pliocene.

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[4] Bull. 53, U. S. National Museum.

Only one specimen of this interesting species was found at the type locality but it is abundant at locality 207 and shows but little variation. On account of its wide, reamed umbilicus and lack of spiral sculpture or carinæ it clearly belongs to the genus *Vorticifex.* The heavy ribs distinguish it from other species of the genus, even if it were not for its small size. There are costate specimens of *Parapholyx packardi* in abundance in the same deposit, but in them the altitude of the shell is much greater in proportion to the diameter, the umbilicus is very small or absent, and specimens of the same size only have half as many whorls. It differs from *V. tryoni* by its smaller size and much coarser sculpture.

VORTICIFEX, SP.

Several lots of material from Lake County, southeastern Oregon, contain imperfect remains of a huge costate species of *Vorticifex.* It is decidedly different from any known species but no specimen is sufficiently well preserved to serve as a type although the characters can be fairly well determined from all. The spire is almost flush with the top of the rounded body whorl which is marked with heavy ribs, entirely to the aperture. The distance between these ribs is more than two millimeters and they are as perfectly formed as the sculpturing on any marine mollusk, a unique character among North American fresh-water species. The umbilicus is narrow, deep and angulated around the margin. The characters of the aperture could not be determined with certainty. This is one of the most interesting discoveries in fresh-water molluscan paleontology in the west and it is to be regretted that the species is not represented by well preserved specimens.

GENUS: LANX CLESSIN

LANX MORIBUNDUS, N. SP.

Plate 1, figures 8 and 9

Shell ovate, the apex about one-third the distance from the anterior end. Spire elevated and acutely pointed, both inside and outside. Sculpture consists of rough irregular growth ridges, no radial markings; the irregularities of the outside are visible on the inside as concentric ridges of uneven strength. Length, 17.5 mm.; width, 14.5 mm.; height, 8.7 mm.

Type No. 18 University of Oregon. Cast of same, No. 673, Mus. California Acad. Sci.

Type from University of Oregon locality 210, Warner Lake beds, eastern Oregon. Pleistocene.

This singular species is the largest of North American freshwater limpets. The collection at the type locality, where it is fairly common, contains one imperfect specimen which is more than 22 millimeters long; the type is of only average size. The closest relative of the species is *Lanx undulatus* (Meek)[5] described from the Kaw-Sow Mountains, Nevada. That species, however, has distinct undulations on the posterior slope and the anterior slope is more decidedly concave. In the series of specimens of *moribundus* the shape is found to be decidedly variable in outline but the height of the shell is more constant. It was also found at localities 209 and 219, both in the vicinity of Warner Lake.

LANX NUTTALLII (HALDEMAN) ?

Plate 1, figure 7

Ancylus (Velletea) nuttallii Haldeman, Monog. Freshwater Univalve Shells, pt. 3, p. 3, inside of back cover, 1842. Oregon—DeKay, New York Moll., p. 13, 1843.

Acroloxus nuttallii Hald. Binney, Smith. Misc. Coll. No. 143, p. 147, 1865. Original description repeated.—Cooper, Proc. Calif. Acad. Sci. Vol. 4, p. 100, 1870. Brief description, no localities.—Cooper, Proc. Calif. Acad. Sci. Vol. 4, p. 174, 1972. Snake River, Washington, one-half inch long, sinistral apex. Alameda County, [California?]

Ancylus nuttalli Hald. Carpenter, Smith. Misc. Coll. 252, p. 85, 1872. A note by J. G. Cooper states that this is questionably equal to *A. caurinus* (Wm. Cooper (nomen nudum) of the Pac. Rail. R. Rep. Vol. 12, pt. 2, p. 378, 1860. J. G. Cooper later (Proc. Calif. Acad. Sci. 2nd ser. Vol. 3, pp. 70-91, 1890) considered *caurinus* distinct and Dall (Harriman Alaska Exp. Vol. 13, 1905) doubtfully referred it to *A. fragilis*, so the above note in Carpenter's report may safely be ignored.

Acroloxus nuttalli Hald. Carpenter, Smith. Misc. Coll. No. 252, p. 161, 1872. Oregon. Copy of Binney's record, Syn. Air Breath. Moll. of N. A., Smith. Inst. No. 111, Dec. 9, 1863.

Lanx nuttalli (Haldeman), Hannibal, Proc. Mal. Soc. London, Vol. 10, p. 149, 1912. Brief description. Listed from Columbia River and tributaries. Following are listed as synonyms: *crassus* Haldeman; *kooteniensis* Baird; *subrotundatus* Tryon.

Lanx nuttallii (Haldeman), Walker, Univ. Mich. Misc. Pub. No. 6, p. 117, 1918. Citations of Binney and Haldeman as above.

The identification of the fossil shell from Warner Lake beds, University of Oregon locality 212, with this species has necessarily been made with some doubt. *A. nuttallii* has never been figured, apparently, and no description of more than three lines has been seen. Of course for identification purposes we have little more than a nude name. If the fossil were perfect, Haldeman's name would be ignored as unrecognizable but, as the figure on Plate 1 shows, our shell is decidedly too imperfect to serve as a type specimen. The apex and part of the margin are missing.

GENUS: PALUDESTRINA D'ORBIGNY

PALUDESTRINA MICROCOCCUS (PILSBRY)

Plate 4, figure 5

Amnicola micrococcus Pilsbry, in Stearns, North Am. Fauna No. 7, p. 277, fig. 1, 1893. Oasis Valley, Nevada. Death Valley, California.—Pilsbry,

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[5] Meek, F. B. Proc. Acad. Nat. Sci. Phila., 1870, p. 57. Geol. Exp. 40th Parallel, Vol. 4, p. 186, pl. 17, figs. 12 a-b, 1877.

Nautilus, Vol. 12, p. 121, 1899, Nye Co., Nevada, Esmeralda Co., Nevada, Inyo and Kern Counties, California.—Pilsbry, Nautilus, Vol. 29, p. 111, 1916. Compared to *neomexicana.*

Nine specimens from University of Oregon locality 212 differ from this desert form only in being slightly larger in size. This does not seem a sufficient difference to warrant specific separation. The shape and number of whorls in the two are the same. The nine specimens do not show an appreciable range in size, all are about the same. One which is figured measures: altitude, 2.2 mm.; diameter, 1-7 mm.

The generic position of the western representatives of this group has not been satisfactorily determined. Since most of them have been placed in the genus *Paludestrina,* it seems best to retain them all there until the question can be thoroughly solved. *Amnicola* has usually been applied to the short spired forms and *Paludestrina* to the longer ones, a distinction which appears of rather minor value in this case.

Genus: Valvata Müller

VALVATA OREGONENSIS, N. SP.

Plate 3, figures 1-18; plate 4, figures 1-4

Valvata whitei Hannibal, Nautilus, Vol. 23, pp. 104, 107, 1900. (First mentioned species.)

Valvata calli Hannibal, Nautilus, Vol. 23, pp. 104, 107, 1910.

Valvata tricarinata (Say), Hannibal, Proc. Mal. Soc. Lond. Vol. 10, p. 197, 1912 (in part).

Shell composed of four whorls, marked with none to three spiral carinæ. Spire normally low and umbilicus wide, exposing all the whorls to the apex. There is great variation in the height of the spire and with its increase there is a proportionate decrease in the width of the umbilicus. The apical two whorls are flat and planulate, smooth and shining, unmarked with carinæ even when the remainder of the shell may have three. Sculpture is comparatively uniform in character, being composed of fine growth lines.

MEASUREMENTS

Diameter, mm.	Altitude, mm.
8.0	5.0 (Type ecarinate)
7.8	5.3
6.9	3.7
5.3	3.8
6.5	3.7
6.1	3.2
6.3	4.4
4.6	4.0
6.2	5.4–5.2
5.2	5.0
4.6	2.6

Type No. 19, 10 paratypes, Condon Museum, University of Oregon. Casts of same, No. 674 Mus. California Acad. Sci.

Type from University of Oregon locality 212, Warner Lake beds, eastern Oregon. Pliocene.

This is the largest North American *Valvata,* one huge broken specimen being almost 10 mm. in diameter. It is characterized by its flat nuclear whorls and generally flat shell. Only rarely is the spire as elevated as the maximum shown in the figures, while great numbers are as flat as the lowest. The thickness of the shells is greater than of any other species seen. *Valvata virens* from Clear Lake, California, has a uniformly higher spire and is never carinated; also the suture is deeper and the peristome is attached to the body whorl in part. In *V. oregonensis* the peristome is entire. *V. utahensis* Call[6] has a uniformly higher spire, deeper suture and narrower umbilicus. Moreover, although it is a carinate species, the nuclear whorls are not discoidal. *V. sincera* likewise has deeper sutures and an acute apex. The new species of course resembles the various forms of *V. tricarinata* more than any other but this last does not have all of the variations in the same colony, at least not in the colonies familiar to me. The carinæ of *tricarinata* are high and acute while in *V. oregonensis* they are rounded when present. Also in *tricarinata* the sutures are deeper, the sculpture as a rule coarser, and the nuclear whorls are elevated even in the low spired forms of the species.

This species was briefly described under two names in 1910 by Hannibal. Or at any rate there are two specimens in Stanford University which are marked "types" of *V. whitei* and *V. calli,* and they answer to the descriptions which accompany those names. Dr. J. P. Smith kindly permitted casts of them to be made for the California Academy of Sciences where they bear the numbers 643 and 644. These species were described from specimens collected near Sumner Lake, Oregon, by F. M. Anderson. Hannibal never published illustrations of his species and later threw both of them into the synonomy of *V. tricarinata.*

It may be challenged that all of the variations shown on plates 3 and 4 cannot belong to the same species but they all came from a single block of material, the longest dimention of which was not over three inches. Under such a circumstance and with every possible stage of intergradation, a multiplicity of names would seem superfluous.

V. oregonensis was a very common species in eastern Oregon in Pleistocene time. The University of Oregon collection contains specimens from numerous localities about Warner Lake, Snake River Valley and in Lake County.

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[6] Call, R. E. Bull. 11, U. S. Geol. Surv., p. 44, pl. 6, figs. 1-3. 1884.

GENUS: VIVIPARUS MONTFORT

VIVIPARUS, SP.

One lot of material from University of Oregon locality 211, said to have come from between Crooked River and Harney Lake, Oregon, consists entirely of compressed shells, thoroughly cemented and crystallized. All are so badly distorted that specific identification is impossible but conspicuous in the mass is a robust *Viviparus* similar to some of the species, *leai* for instance, from the Laramie and Eocene strata of the Rocky Mountains. It is possibly the same as *V. washingtonianus* Hannibal,[7] but does not appear to be subcarinate on the periphery. The last was described from the "Tejon" Eocene strata of Little Falls, Washington. The Oregon shells appear more like *V. turneri* Hannibal[8] described from Eocene strata, Truckee Lake beds, Nevada. Since no member of the family Viviparidæ is known to have persisted west of the Rocky Mountains after the Eocene, it seems safe to refer the material from locality 211 to that age.

GENUS: PISIDIUM PFEIFFER

PISIDIUM, SP.

The collection of shells from University of Oregon locality 212, Warner Lake beds of eastern Oregon, contains numerous specimens of *Pisidium*. There appear to be two species represented, a smooth one and a rugose one, but the nomenclature in this genus is so tremendously confused that identification is exceedingly difficult, well nigh impossible with certainty.

LIST OF LOCALITIES

University of Oregon locality numbers 200, 201, 202, 203, 204, Snake River Valley, Oregon. Pliocene. Contains *Valvata oregonensis, Parapholyx packardi, Pisidium* sp., and a huge species of costate *Vorticifex*. Preservation is so poor that specific identification is not possible with certainty, the shells being usually represented by casts, or impressions. The *Vorticifex* is undescribed and represented by fragments at several localities.

205. Central Oregon. Pliocene. Contains *Valvata oregonensis, Parapholyx packardi* and a species of *Pisidium* firmly cemented together. The shells are not easily extracted.

206. No locality. Contains poorly preserved *Valvata oregonensis, Parapholyx packardi* and the costate *Vorticifex*.

207. Snake River Valley, Oregon. Pliocene. *Vorticifex condoni* abundant; *Pisidium*, two species abundant; *Parapholyx packardi* and *Valvata ore-*

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[7] Hannibal, H. Proc. Mal. Soc., London, Vol. 10, p. 194, pl. 8, fig. 32, 1912.
[8] *Opt. Cit.*, p. 194, pl. 8, fig. 31.

gonensis not so common. Material is firmly cemented together but shells come out fairly well preserved.

208. Snake River Valley, Oregon. Pliocene. Contains *Valvata oregonensis, Parapholyx packardi, Planorbis scabiosus* and numerous Ostracod shells firmly cemented together with sand and shell fragments and pieces of lava rock.

209. Warner Lake, Oregon. Plestocene? Hard calcareous cement, the shells of which have been dissolved away. Contains casts or imprints of *Valvata oregonensis, Parapholyx packardi, Pisidium* sp., *Vorticifex* new species, *Vorticifex,* cf. *binneyi* and *Lanx moribundus.*

210. Warner Lake, Oregon. Pleistocene? Well preserved fossils, toughly cemented together with carcareous deposit. Contains *Valvata oregonensis, Parapholyx packardi, Vorticifex condoni, Vorticifex binneyi, Paludestrina micrococcus, Pisidium* sp., *Carinifex* sp., *Lanx moribundus.*

211. Between Crooked River and Harney Lake, Oregon. Eocene? Contains *Viviparus.* Material consists of shells and fragments thoroughly crushed, compressed and cemented.

212. Warner Lake, Oregon. Pliocene. Well preserved fossils in loose sandy cement. Contains *Valvata oregonensis, Parapholyx packardi, Lanx* sp., *Pisidium* sp., *Planorbis scabiosus, Paludestrina micrococcus, Vorticifex condoni* and *Carinifex* (?) sp.

213. Warner Lake, Oregon. Pliocene. Well preserved shells loosely cemented together. Contains *Valvata oregonensis, Parapholyx packardi* and a *Pisidium.*

214, 215, 216. Lake County, southeastern Oregon. Pliocene. Contains *Valvata oregonensis, Parapholyx packardi* and the huge costate *Vorticifex.* Matrix is a firm cement and shells are represented by casts and imprints.

217. Lake County, southeastern Oregon. Contains *Lanx* sp. and two other species of Gastropods which cannot be determined. The material is a hard limestone, brown in color, the shells being preserved as casts only.

218. Lake County, Oregon. Pliocene. Well preserved shells loosely cemented together. Contains *Valvata oregonensis, Parapholyx packardi* and a *Pisidium.*

219. Warner Lake, Oregon. Pleistocene? Hard calcareous cement, the shells of which have been dissolved away in large part. Contains casts and molds of *Valvata oregonensis, Parapholyx packardi, Pisidium* sp., *Vorticifex* new species and *Vorticifex* cf. *binneyi, Lanx.*

Transmitted July 13, 1922 Issued August 29, 1922

EXPLANATION OF PLATES

PLATE 1

Figures 1, 2, and 3.—*Planorbis condoni,* n. sp. Type. Diameter, 2.67 mm.; altitude, .55 mm.

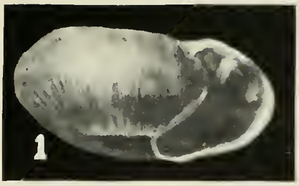
Figures 4, 5, and 6.—*Planorbis scabiosus,* n. sp. Type. Diameter, 3.4 mm.; altitude, 1.1 mm.

Figure 7.—*Lanx nuttallii* (Haldeman)? Length, 6.4 mm.; width, 5.7 mm.

Figure 8.—*Lanx moribundus,* n. sp. Type. Length, 17.5 mm.; width, 14.5 mm.; height, 8.7 mm.

Figure 9.—*Lanx moribundus,* n. sp. Paratype. Length, 15.1 mm.; width, 11.5 mm.; height, 8.9 mm.,

PLATE 1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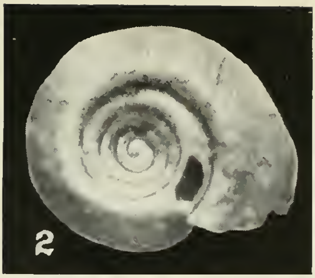
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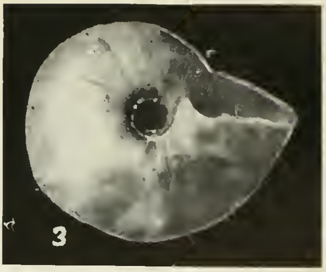
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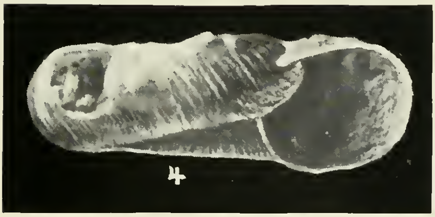
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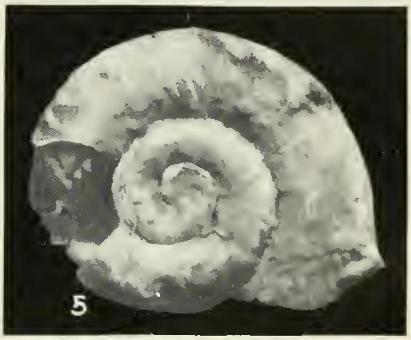
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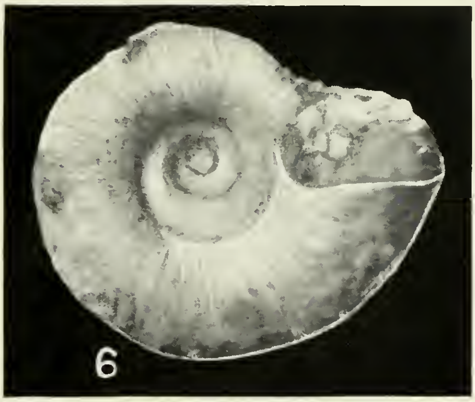
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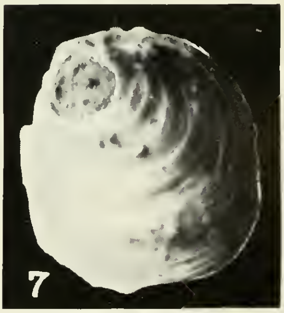
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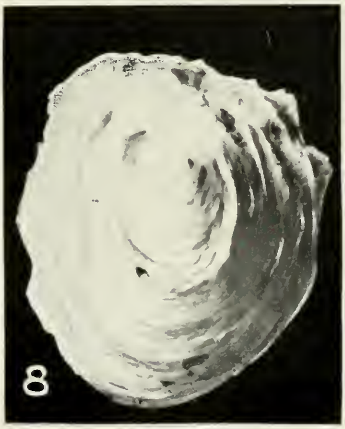
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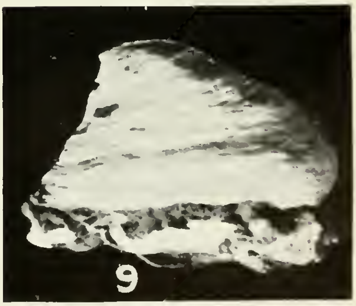
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PLATE 2

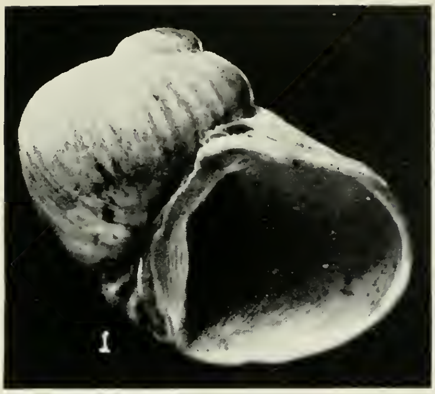
Figure 1.—*Parapholyx packardi*, n. sp. Type. Diameter, 15.4 mm.; altitude, 13.2 mm.

Figure 2.—*Parapholyx packardi*, n. sp. Paratype. Diameter, 14.0 mm.; altitude, 11.3 mm.

Figure 3.—*Parapholyx packardi*, n. sp. Paratype. Diameter, 19.5 mm.; altitude, 17.1 mm.

Figure 4.—*Parapholyx packardi*, n. sp. Paratype. Diameter, 17.8 mm.; altitude, 15.5 mm.

Figure 5.—*Parapholyx packardi*, n. sp. Paratype. Diameter, 13.7 mm.; altitude, 11.4 mm.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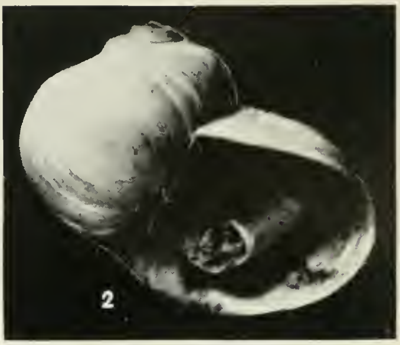
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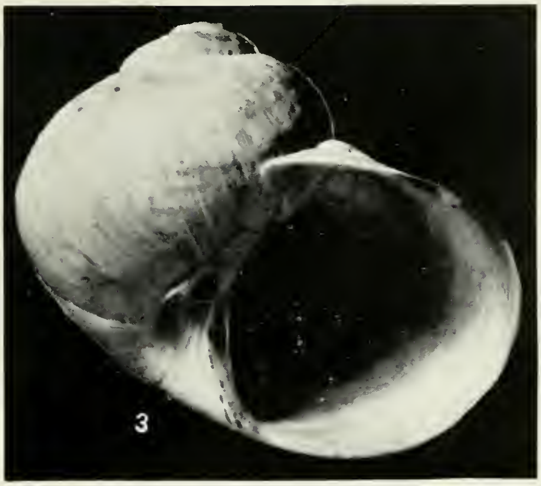
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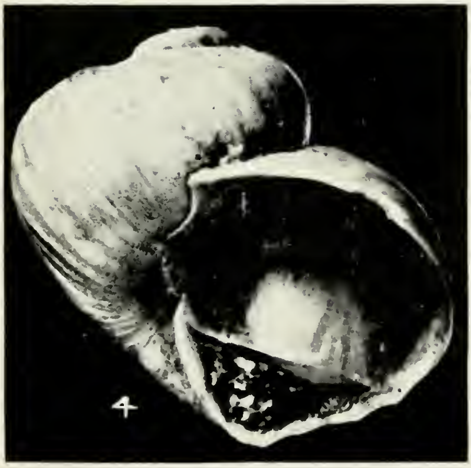
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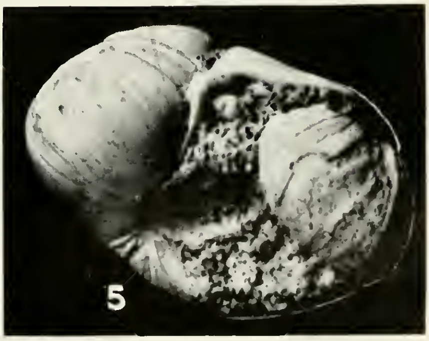
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PLATE 3

Figures 1 and 2.—*Valvata oregonensis*, n. sp. Type. Diameter, 8.0 mm.; altitude, 5.0 mm.

Figures 3 and 4.—*Valvata oregonensis*, n. sp. Paratype. Enlarged 5.5 diameters. Showing elevation of spire and slight formation of marginal carina.

Figures 5 and 6.—*Valvata oregonensis*, n. sp. Paratype. Enlarged 5.5 diameters. Spire much elevated and marginal carina more pronounced.

Figures 7 and 8.—*Valvata oregonensis*, n. sp. Paratype. Enlarged 5.5 diameters. Spire depressed, dorsal carina present.

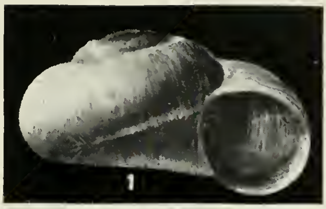
Figures 9 and 10.—*Valvata oregonensis*, n. sp. Paratype. Enlarged 5.5 diameters. Spire depressed, basal carina present.

FFigures 11 and 12.—*Valvata oregonensis*, n. sp. Paratype. Enlarged 5.5 diameters. Spire greatly elevated, marginal carina present.

Figures 13 and 14.—*Valvata oregonensis*, n. sp. Paratype. Enlarged 5.5 diameters. Spire greatly depressed, basal carina present.

Figures 15 and 16.—*Valvata oregonensis*, n. sp. Paratype. Enlarged 5.5 diameters. Spire normal; dorsal and basal carinæ present.

Figures 17 and 18.—*Valvata oregonensis*, n. sp. Paratype. Enlarged 5.5 diameters. Spire elevated, dorsal, marginal and basal carinæ present.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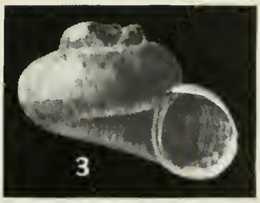
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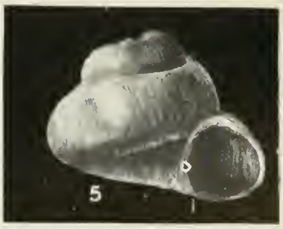
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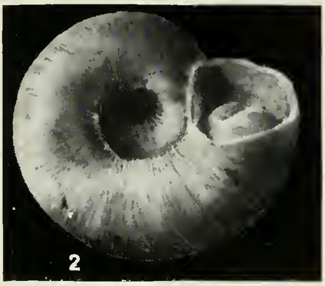
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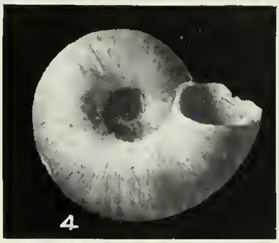
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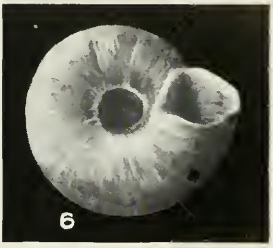
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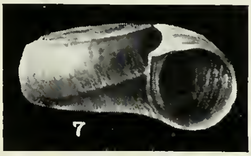
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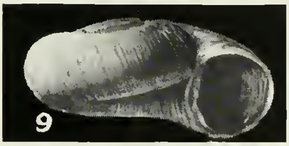
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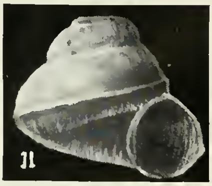
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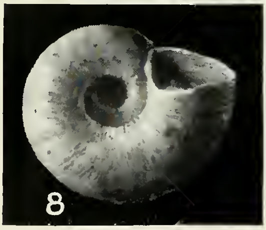
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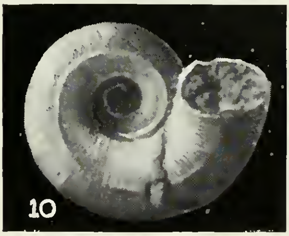
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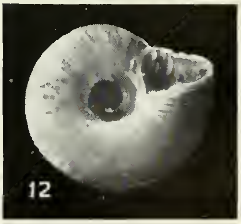
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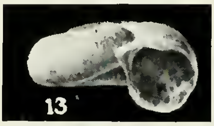
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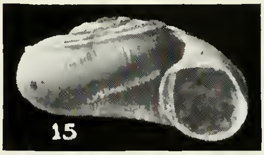
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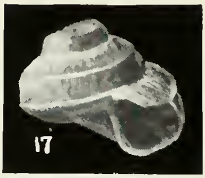
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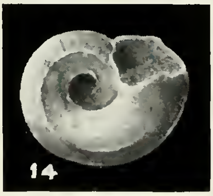
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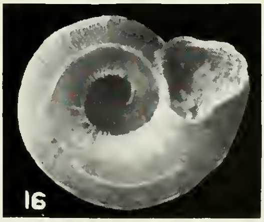
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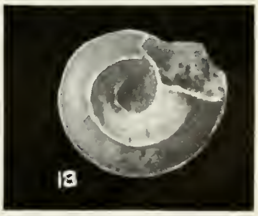
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Plate 4

Figures 1 and 2.—*Valvata oregonensis*, n. sp. Paratype. Enlarged 5.5 diameters. Dorsal, marginal and basal carinæ present.

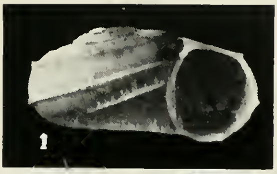
Figures 3 and 4.—*Valvata oregonensis*, n. sp. Paratype. Enlarged 5.5 diameters. Dorsal, marginal and basal carinæ present.

Figure 5.—*Paludestrina micrococcus* (Pilsbry). Diameter, 1.7 mm.; altitude, 2.2 mm.

Figures 6, 7, and 8.—*Vorticifex binneyi* (Meek). Fig. 6, measures: diameter, 14.1 mm.; altitude, 9.2 mm. Fig. 7, measures: diameter, 17.1 mm.; altitude, 9.8 mm. Fig. 8, measures: diameter, 12.8 mm.; altitude, 9 mm.

Figures 9 and 10.—*Vorticifex condoni*, n. sp. Type. Diameter, 4.4 mm.; altitude, 2.1 mm.

PLATE 4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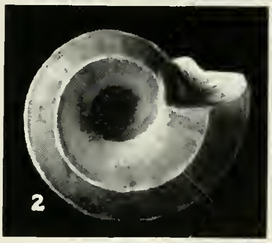
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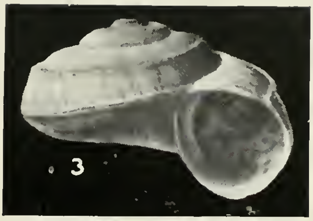
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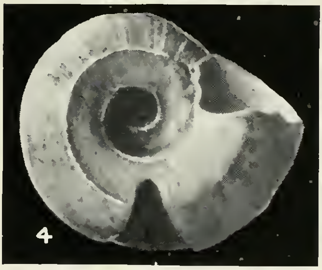
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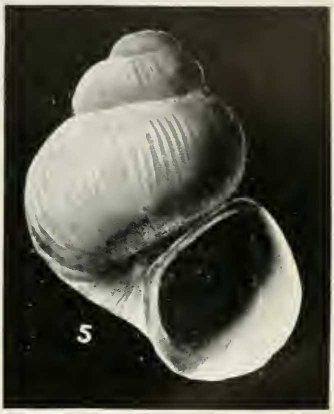
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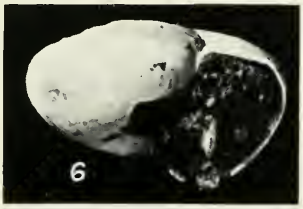
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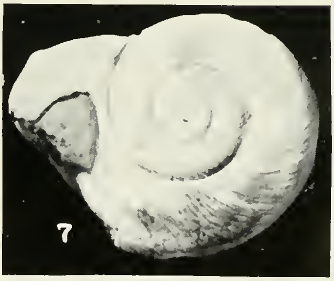
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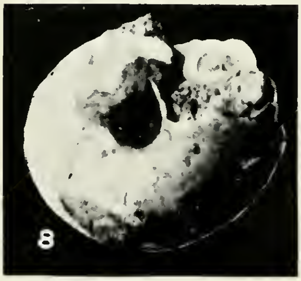
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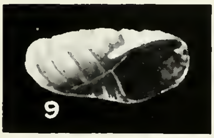
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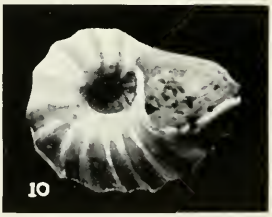
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